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Renewable energy education and industrial arts : linking knowledge producers with knowledge users.

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RENEWABLE ENERGY EDUCATION AND INDUSTRIAL ARTS:
LINKING KNOWLEDGE PRODUCERS WITH
KNOWLEDGE USERS

A Dissertation Presented

By

Richard L. Foley

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ABSTRACT

RENEWABLE ENERGY EDUCATION AND INDUSTRIAL ARTS:
LINKING KNOWLEDGE PRODUCERS WITH
KNOWLEDGE USERS

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Purpose of the Study

The purpose of this study was to introduce renewable energy technology into the industrial arts programs in the State of New Hampshire by providing the following information for decision-making: 1) a broad-based perspective on renewable energy technology; 2) the selection of an educational change model; 3) data from a needs analysis; 4) an initial screening of potential teacher-trainers.

Methodology

The Wolf-Welsh Linkage Model was selected as the knowledge production/utilization model for bridging the knowledge gap between renewable energy experts and industrial arts teachers. The Coffing and Hutchinson Needs Analysis Methodology was used to identify and

prioritize definitions of needs related to two statements: industrial arts teachers' need for knowledge to teach renewable energy education a) as defined by industrial arts teachers and b) as defined by renewable energy experts.

Results

Ninety-six renewable energy experts were identified by a three-step peer nomination process (92% response rate).

A list of 493 discrete needs was identified by thirty-one definers representing the State's 309 industrial arts teachers and the renewable energy experts (100% response rate). The 493 need statements were prioritized by teachers (70% response rate) and experts (92% response rate). The degree of agreement/disagreement between the teachers and experts was determined by direct comparisons and by a statistical comparison using a rank order correlation ($\underline{p}$ = .6273).

The degree to which individual teachers agreed or disagreed with the group of experts was measured by a series of rank order correlations. These 200 correlations were labeled "indices of congruency".

A stepwise multiple regression technique was used to measure the predictive value of 126 demographic variables on the dependent variable, teachers' indices of congruency.

Lastly, sixty-seven industrial arts teachers were nominated by their colleagues as potential in-service instructors.

Conclusions

The experts stressed the conceptual foundations, economic justifications, and the scientific and quantitative basics of renewable energy technology. The teachers focused on wood-burning technology, educational strategies, and the more popular "alternative energy" sources such as windpower, hydropower, photovoltaics, and biomass. The most emphatic contribution of the needs analysis was the experts' and teachers' shared perception that residential/commercial building design, retrofitting, and construction is the single most important practical, technical area for the application of renewable energy technology.

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CHAPTER I

ORIENTATION TO THE STUDY

Introduction

In the absence of a coherent, comprehensive national energy policy, of consistent, reliable and valid public energy information, and of a well-defined and strongly supported energy education system, the need exists for Industrial Arts teachers and leaders to determine for the profession the appropriate subject content, curriculum designs, teaching strategies, and classroom activities for delivering renewable energy literacy and related skills. These policy decisions cannot be based on a national energy plan that does not exist; these decisions cannot be delegated to energy education systems that are not in place; and these decisions should not be grounded on self-contradictory information sources. Such policy decisions require a broad-based perspective of problem identification and historical context.

These policy decisions also require a model of knowledge transfer or educational change that can assist industrial arts leaders in maximizing the impact of their efforts to integrate renewable energy education content into traditional industrial arts programs. For better or for worse, manual skills training has retained its ascendency as the ranking goal of industrial arts. Furthermore, the delivery system comprised of six traditional trade areas and dependent upon individual student projects has weathered reform efforts in the past decade to reorganize along various cluster configurations. In fact, in the last ten years, the issues of rapid technological change, the advent of the computer, new horizons for high technology areas, the emergence of interdisciplinary approaches stressing science, mathematics, social ecology and energy education, as well as re-evaluations of the relationships between industrial arts and special education, elementary education and vocational education, have all stressed the need for change in industrial arts. However, these and other issues appear to have had minimal impact on the traditional assumption bases of regular classroom teachers in industrial arts, and, in turn, minimal impact on industrial arts programming and daily activities (Standards for Industrial Arts Programs Project Staff 1980; Andrews 1976). In short, change agents face a tough nut to crack.

If the entrenched philosophies and practices of industrial arts and the wide variety of new fields of knowledge represent two strikes against change in industrial arts curriculum, the advocates of change have compiled a record that is another reason for discouragement. Proponents of change in industrial arts, as a group, have added confusion to the business of making things better. Despite the veracity of singular efforts, the impression of change-related oration and research is one of disparity. Attention has been focused alternately on the following:

- expert testimony
- philosophies, goals and objectives
- curriculum design for teacher-trainer institutions
- curriculum design for secondary level programs
- change orientation of secondary level teachers
- types of student clienteles
- state certification standards

- adaptability of potential subject content areas
- pre-vocational roles
- model project programs
- teacher inspiration

These three inherent conditions--traditionalism, knowledge explosion, and disparate change promotions--combine to discourage change in industrial arts programming on a state, regional, or national level. Therefore, designating an educational change model and designing a research scheme that complements this model are necessary and realistic goals of this study. A prerequisite for any change advocacy aimed at industrial arts should be the selection of an appropriate, well-designed and organized master plan or model that communicates how knowledge diffusion/utilization takes place. In other words, how are advances in practical knowledge explained by social theory. If, for instance, changes in industrial arts curricula are encouraged by the field's professionals, what steps must be followed and successfully completed in order to effect the desired changes. If this theoretical framework is first established, then research can be targeted in a logical sequence as part of a known, comprehensive process designed to transfer knowledge from knowledge producers to knowledge users.

The framework for tackling the problems of knowledge diffusion/utilization selected for this study is the Wolf-Welsh Linkage Methodology (Wolf 1984) which contains nine primary steps and numerous sub-steps. Of these nine primary steps, this study addresses the first two steps as they apply to one of the many issues challenging the field of industrial arts--how can renewable energy education knowledge be communicated to the knowledge users, industrial arts teachers.

Purpose and Problem of the Study: Bridging the Knowledge Gap between Renewable Energy Education Experts and Industrial Arts Teachers

In the past four years, the introduction of renewable energy technology into the State of New Hampshire's industrial arts programs has become a major objective for both the State's industrial arts teachers and the State Department of Education. Four series of events provide ample evidence in support of this targeting of a specific "new knowledge." Assessments of teachers' needs for inservice training, the success of workshops presented by renewable energy experts, the clustering of the State's industrial arts program, and the certification of industrial arts teachers by cluster areas--all focus on renewable energy technology in industrial arts.

In the first case, in 1980, the Consultant for Industrial Arts in New Hampshire, and the leaders of the New Hampshire Industrial Education Association (NHIEA) conducted a survey of their teaching colleagues to determine their needs for in-service training. Alternative energy ranked number one, solar energy ranked fourth. The number two and three ranked items, inexpensive projects and building construction practices, were linked directly by some respondents to the alternative/solar energy needs. The State Consultant and NHIEA representatives judged these survey results to be consistent with ongoing, informal teacher requests for in-service programming.

Furthermore, the State Consultant and the NHIEA President reiterated during the 1984 Industrial Arts Festival and the business meeting (Spring, 1984) of the NHIEA that alternative energy had remained as one of the top, if not the top priority for technical updating over the previous four years.

As a result of the 1980 survey, one of seven in-service workshops for the 1981-1982 school year was designed to introduce several renewable energy experts to the classroom teachers. Forty teachers participated in the day-long workshop, approximately double the attendance figures for the other six workshops. The customary workshop evaluation process produced a strong demand for additional workshops in renewable energy subject areas. During the spring of 1983, this researcher and the State Consultant organized and supervised another weekend-long, hands-on workshop featuring one expert from the previous energy workshop. Despite the weekend schedule and the fact that the advertised enrollment was limited to sixteen participants, twenty-seven teachers applied. The sixteen teachers selected constructed projects representing the technologies of energy conservation, windpower, and solar energy. Again, the teachers' evaluations stressed the need for more information and another hands-on workshop.

Third, during 1983 and 1984, educational leaders in the State of New Hampshire indicated their support for the introduction of renewable energy technology into industrial arts programs through official channels. The State Department of Education in 1983 revised the guidelines for industrial arts and reorganized the traditional craft areas (woodworking, drafting, metals, etc.) under three cluster headings: 1) Materials and Process Technology, 2) Visual Communication Technology, and 3) Energy and Power. This "clustering" of industrial arts programs reflected a popular curriculum reform effort for the industrial arts profession during the past decade or so. More importantly, this revision of the State's guidelines for the first time listed energy conservation and alternative energy as content areas. The topic areas in Energy and Power included the following: electricity, electronics, power mechanics, transportation, alternative energy, and energy conservation. In other words, renewable energy technology was officially "recognized" as a content area comparable to the traditional craft areas. Furthermore, the State's 1984 revised standards for secondary education listed power and energy as a top priority area for industrial arts. These two policy mandates clearly represented an attempt to promote renewable energy technology as content areas for the State's industrial arts programs.

Lastly, in the fall of 1983, the section of the New Hampshire Certification Standards for Teaching that refers to the field of industrial arts was amended by the addition of a new certification procedure. Under this procedure, a teacher-candidate could apply for certification for teaching industrial arts in one of the recently-approved three cluster areas: 1) Materials and Process Technology, 2) Visual Communication Technology, and 3) Energy and Power. In outlining teachers' competencies in various content areas, the plan recognized, as does the State's guidelines, the two separate and distinct knowledge areas subsumed under the Energy and Power umbrella--alternative sources of energy and energy conservation. This "cluster" certification represented a radical departure from the traditional reliance on the "comprehensive" certification. And by its action, the State's certification office forced the involvement of New Hampshire's sole industrial arts teacher-training institution, Keene State College. Since 1983, the College's Industrial Education and Technology Department has been addressing the problem of designing and providing programs for teacher-candidates pursuing certification in cluster areas. As part of that review process, the Department was introduced to the fact that it did not offer courses in renewable energy technology.

From the grassroots level to the state-policy level, industrial arts teachers and leaders have communicated that renewable energy technology must be incorporated into the State's industrial arts programs. These four series of events stress the need for an appropriate data base for policy decision-making at the state level. The infusion of renewable energy technology into the State's industrial arts programs presents the problem of bridging the gap between knowledge producers (renewable energy experts) and knowledge users (industrial arts teachers).

Objectives of the Study

This study initiates the process of bringing the knowledge of renewable energy education into the field of industrial arts by following the procedures delineated by Parts I and II of the Welsh-Wolf Linkage Methodology. Specifically, this study's objectives are to provide the leaders in industrial arts in the State of New Hampshire with the following information:

1. A broad-based perspective of national energy issues, govern mental intervention, energy education efforts, and their relation to industrial arts--an overview that will justify the focus on renewable energy technology as opposed to energy technology in general.
2. The introduction of a knowledge production/knowledge utilization model compatible with in-service program design and the presentation of the information required by two steps of the above model's nine-step procedure.
3. A list of identified, prioritized needs of renewable energy knowledge from two targeted New Hampshire groups--industrial arts teachers and renewable energy experts.
4. Several suggestions concerning the identification of "influentials" (within the ranks of New Hampshire industrial arts teachers) who would form a core of potential teacher-trainers.

In Chapter II of this study, the researcher addresses the task of fulfilling the first two objectives. First, this Chapter establishes a perspective for future decision-making. National energy issues, energy crises, national energy policies, energy education, public perceptions of energy issues are all reviewed as prerequisites for recognizing the importance of renewable energy technologies. Secondly, this Chapter introduces two models: 1) a definition of renewable energy education that stresses the selection of renewable energy and energy conservation technology, and 2) the Wolf-Welsh Linkage Model that offers a blue-print for change in industrial arts education.

In Chapters III and IV, the researcher utilizes the Needs Analysis Methodology (Coffing and Hutchinson 1974) to provide the data for decision-making listed in the third objective. In order to bridge the gap between knowledge producers (renewable energy experts) and knowledge users (industrial arts teachers), the researcher identifies, prioritizes, and compares definitions of needs related to two statements, in the following form--who needs what, as defined by whom?:

a) industrial arts teachers' need for knowledge to teach renewable energy education as defined by industrial arts teachers.

b) industrial arts teachers' need for knowledge to teach renewable energy education as defined by renewable energy experts.

The basic question addressed by the investigation of these two needs statements is how do the primary knowledge users (industrial arts secondary level teachers) perceive the body of renewable energy knowledge they need to acquire for teaching purposes as compared to how the knowledge producers (renewable energy experts) perceive the body of renewable energy knowledge the primary knowledge users need to acquire for teaching purposes. This comparison can be examined through the testing of the first of the three hypotheses listed below.

The fourth objective, identifying potential teacher-trainers, is also covered in Chapters III and IV. This screening effort involves the second and third hypotheses of this study (listed below), and, therefore, several statistical procedures. In both hypotheses, the dependent variable is described as "congruency" or the extent to which individual industrial arts teachers agree with renewable energy experts' opinions concerning needs. In the second hypothesis, the relationship between this dependent variable of congruency and the independent variables of selected demographic data for teachers is studied. In the the third hypothesis, the independent variable is the rank order of influential status, or how often individual teachers are nominated by their peers as potential in-service instructors. Both these hypotheses, then, attempt to assist in the identification of teacher-trainers. All three hypotheses are listed below.

Hypotheses

This study will investigate the following null hypotheses:

H_1 There will be no relationship between the perceived needs of industrial arts teachers and the perceived needs of renewable energy experts pertaining to the teachers' need for knowledge to teach renewable energy education.

H_2 There will be no relationship between selected demographic variables for industrial arts teachers (professional development, teaching experience, age, subject area, etc.) and the measures of congruency (the extent to which individual industrial arts teachers agree with renewable energy experts' opinions concerning needs).

H_3 There will be no relationship between the rank orders of influential status of the industrial arts teachers and their congruency with renewable energy experts.

Limitations

This study depends upon one of several social change models that address the transfer of knowledge from producers to users. The Wolf-Welsh Linkage Methodology has been field-tested four times with encouraging results; however, more systematic field tests of this methodology are required to ascertain its strengths and deficiencies. For the purposes of this study, the Wolf-Welsh Methodology applies directly to the knowledge production/knowledge utilization gap affecting renewable energy education and industrial arts, and establishes a frame of reference for the disciplined inquiry of this study.

Likewise, the constraints of resources attendant with dissertational-level research conducted by one researcher without outside funding directly affects the application of the Needs Analysis Methodology as a research design. Resource consumption of money, time, talent and so on limited this study to obtaining needs data and reporting on the definitions of needs. The next logical step in the

Needs Analysis Methodology involves determining how well the defined needs are being met--either currently or as projected into a future time frame. This study does not obtain and report measurements of need fulfillment. Due to this stopping point, this study meets the requirements of the first three steps of Part II (Identification of a Targeted Audience's Need to Modify Some Aspect or Aspects of Professional Practice) of the Wolf-Welsh model. The issue of who will participate in the final selection of the specific needs to be addressed and the selection of criteria to facilitate identification of those specific needs will not be researched.

Along these same lines, this researcher must make clear that the identification and prioritization of perceived needs does not indicate what needs for knowledge should be selected for teacher-training, what methods of knowledge delivery should be employed, how secondary industrial arts curricula should be modified, and other corollary questions relating to educational change processes. These issues and their respective data requirements are addressed in the subsequent steps of the Needs Analysis Methodology and the Wolf-Welsh model.

In terms of target populations, this study is limited to industrial arts teachers in grades 7 through 12 in the State of New Hampshire. It does not include elementary industrial arts teachers, home economics instructors, and vocational or technical educators. Only those teachers listed in the 1982-1983 Industrial Arts Directory, published by the New Hampshire State Board of Education, will be used in this study as the knowledge-user group. The other target group, knowledge providers, is defined as renewable energy experts who are oriented in their activities to the State of New Hampshire. They must meet specific qualifications that will be outlined later and be recognized as experts by their peer group. Despite the design of a logical identification process, a process that will be a small study in itself, identification of this expert group surely will include some mis-identification, approximately 5 percent (Doble 1977).

Lastly, the assumption of this research design is that renewable, decentralized energy sources, including conservation, and their attendant subject content are important parts of the energy education knowledge that industrial arts educators should seek to utilize on a national level and in the State of New Hampshire.

Significance

Educational change that reaches the classroom represents several levels of knowledge linkage: teacher-trainer institutions, state and local educational agencies, industrial arts leaders, federal funding sources, career education programs, individual teachers all at one time or another have initiated a knowledge transfer. When the process starts at levels above the school program, pre-service and in-service preparations are common knowledge delivery systems used for teacher-candidates and classroom teachers. In the case of in-service training aimed at stimulating curricular changes and following through on the implementation/evaluation stages, leaders of in-service programs have limited resources--money, presenter and teacher time, talent levels and so forth. It makes sense to support these leaders of in-service programs with a systematic approach to maximizing resources, validating subject content, identifying, prioritizing, and measuring various targeted groups' needs. The Wolf-Welsh model provides a starting point, feasibility checks, alternative routes, and a final destination for linkage agents such as in-service leaders.

This study is an attempt to target renewable energy education as a critical technological issue, one that fairly demands access to industrial arts education, as do so many other new knowledge areas in an accelerating, technologically-oriented society. Once this knowledge area is defined as a distinct entity in the broader context of national problems in energy supply and demand, the next step is to synthesize the knowledge base through the channel of renewable energy experts and to make it available to the knowledge users, the classroom teachers in industrial arts education.

In the broadest sense, this study will provide New Hampshire industrial arts leaders with a frame of reference and two tools to bridge the knowledge production/knowledge utilization gap. The frame of reference is the review of literature; the Wolf-Welsh model and the Needs Analysis Methodology are the tools. The task of bridging the knowledge gap is not a clean, clear-cut challenge. In the absence of a coherent, comprehensive national energy policy, of consistent, reliable and valid public energy information, and of a well-defined and strongly supported energy education system, the leaders in industrial arts in the State of New Hampshire need disciplined inquiry to provide data for policy decision-making.

Terminology

The following specialized terms are defined for the purposes of this study as listed below:

Energy Education

A generic term used to describe a wide variety of efforts to disseminate information about energy aimed at different public groups to meet the needs of various sponsoring agencies. Further delineation of this definition is presented in Chapter II.

Industrial Arts

A segment of general education (grades K through 12) that deals with industry--its organization, materials, occupations, processes, and products, and the problems resulting from the industrial and technological nature of society. (Wilber 1967)

Needs Analysis Methodology

A definitive conceptualization of a research tool as a systematic, operational, standard set of rules and procedures designed to provide needs data for decision-making (Coffing and Hutchinson 1974). The expansion and refinement of this definition are presented in Chapter II.

Renewable Energy Education

A radical redefinition of energy education for the purposes of this study that focuses on conservation and renewable, decentralized energy sources and a social ecology-oriented rationale for their selection. Further developments of this definition are provided in Chapter II.

Wolf-Welsh Linkage Methodology

An accessible instrument for use by knowledge linkage agents that combines appropriate variables, processes, and outcomes in a procedural format that facilitates the communication of knowledge from producers to users (Wolf 1983c). Further definitions of this instrument as a methodology are presented in Chapter II.

CHAPTER II

REVIEW OF THE LITERATURE: Establishing the Rationale for Renewable Energy Education in Industrial Arts

Establishing Perspectives for Decision-Making

Perhaps the most difficult task of this study is to establish a perspective for decision-making that will make meaningful the volumes of inconsistent data about the energy problem and energy education. Controversy, indifference, or misinformation characterizes the pieces of the puzzle that describe the intersection of energy education and industrial arts. Part I, then, of this review of related literature attempts to document the veracity, scope and inexorability of our nation's energy supply/demand as a critical problem, to develop the argument that a comprehensive national energy policy simply does not exist, to work towards a definition of energy education, and to document the failure to date of energy education's attempt to change the perceptions of the public with regard to energy issues. The next major section of the review of literature traces public education's response to energy issues as the larger context for estimating the limited nature and size of the linkage between energy education and industrial arts. Given this background material, in the last section of the literature review a framework is constructed for bridging the energy education/industrial arts knowledge gap. The framework is built upon two foundations: the first is a redefinition of energy education that eliminates the major contributing sources of energy education's "misinformation"; the second is the adoption of the Wolf-Welsh Linkage Methodology as the blueprint for implementing change. On this foundation are built the subsequent steps of disciplined inquiry--research design and instrumentation.

PART I. National Energy Issues, Policies, and Education

Energy Foundations

In anticipation of tracing the development of U.S. energy policy and energy education efforts, it is imperative to review the assumption bases for the emerging theories supportive of conservation and decentralized, renewable energy sources. Briefly, the era of plentiful, inexpensive petroleum supplies is coming to an end. Unless the energy growth rate of this country declines to a zero or negative growth rate, the United States faces a difficult transition period (1980-2000). Continuing dependence on foreign oil and the expectation for a "technical fix" to supplement diminishing domestic oil supplies represent false hopes, as does the "iron link" between Gross National Product (GNP) growth and energy supply growth. The most realistic solutions to the problem of this age of transition must depend upon conservation and development of decentralized, renewable energy sources.

An outline of the statement of the nation's energy problems, the elimination of traditional energy producers' supplies as appropriate solutions, and the case for a solution based on renewable energy are organized in seven parts. For the purposes of this dissertation, the first six parts are noted by title and are accompanied by a list of sources. The full text of the last six parts were presented in an unpublished comprehensive paper (Foley 1982). The last part "The Minority View: The Soft-Path Solution Set of Conservation and Renewable Energy" is included in its entirety in this review of literature because it defines "soft-energy paths", gives a rationale for evaluating conservation as an energy source, and forms the assumption base for redefining energy education--a critical issue for this study.

The first six sections and their respective citations are listed below:

1. Hubbert: Production Curves
   (Hubbert 1971 and 1978) (Stobaugh 1979)

2. Bartlett: Exponential Growth
   (Bartlett 1978) (Hubbert 1978)

3. Stobaugh and Yergin: Problems with Domestic and Foreign Oil Supplies
   (Stobaugh and Yergin 1979a) (Strobaugh 1979)
   (Stobaugh and Yergin 1979)

4. Bupp and Schuller: Problems with Natural Gas
   (Bupp and Schuller 1979) (Lovins 1975)

5. Horwitch: Problems with Coal
   (Horwitch 1979)

6. Bupp and Lovins: Problems with Nuclear Power
   (Bupp 1979) (Lovins 1975)

The basic argument of these six sections is that non-renewable energy sources follow well-defined production curves and that since domestic energy consumption has outstripped domestic energy supplies, the "energy supply gap" has increased with a resultant dependence on the importation of foreign crude oil. The rapid increase of foreign energy imports since 1967 have had a tremendous negative impact on our nation's economy. Solutions to the imported energy problem that propose higher production levels for our traditional non-renewable energy supplies simply run counter to production/supply curves.

In summing up the viability of current conventional energy sources, Stobaugh and Yergin (1979a) concluded that:

> There is little reason to expect conventional alternatives to make a sizable contribution to reducing our dependence on imported oil. Indeed, it is possible that these energy sources--domestic oil and gas, coal, and nuclear power--as a group may not increase their contribution at all to meeting the nation's additional energy needs over the next decade. (p. 9)

The solution set to the current energy problem has been offered over the past decade by advocates of solar energy and conservation; however, despite the rhetoric of U.S. institutions, these alternatives are not taken seriously (Yergin 1979) largely due to institutional barriers (Hall 1978; Lovins 1975 and 1977; Chubb 1979; Rhodes 1980; McDaniel 1979), philosophic assumption bases, inertia, lack of military applications, inappropriate economics, and counter-productive public policy. A brief review of "soft energy paths" provides a definition for an alternative, realistic scenario to the current energy mix and distribution system soon facing bankruptcy.

Lovins (1977) coined the phrase "soft-energy paths" and defined them using five characteristics:

1. They rely on renewable energy flows that are always there whether we use them or not, such as sun and wind and vegetation: on energy income, not on depletable energy capital.

2. They are diverse...so national energy supply is an aggregate of very many individually modest contributions, each designed for maximum effectiveness in particular circumstances.

3. They are flexible and relatively low technology...

4. They are matched in scale and in geographic distribution to end use needs, taking advantage of the free distribution of most natural energy flows.

5. They are matched in energy quality to end use needs. (pp. 38-39)

Soft-energy paths represent a mix of conservation practices and a judicious selection of energy sources that exists today in Western Europe. Yergin (1979) argued that conservation must be viewed as an energy source with positive impact potential for the United States:

1) Conservation, though generally regarded as a descriptor of efficiency, is more accuratly defined as an energy source, no less so than fossil fuels or nuclear energy.

2) Conservation is technically accessible.

3) The United States could consume 30 to 40 percent less energy without disrupting the American lifestyle and standard-of-living.

4) Conservation is cost-competitive with current fuels.

5) Conservation, as a domestic energy source, could displace all imported oil.

6) Since the United States uses one-third of all the world's production of energy, the introduction of American conservation would improve the balance of payments and foreign relations.

7) Conservation may be the most cost-effective, environmentally-sound, and safest way of saving petrodollars.

Likewise, Maidique (1979) provided basic descriptors of renewable energy and several key points and projections:

1) Given reasonable incentives, renewable energy technologies could produce 20 to 25 percent of the United States' total energy requirements by the year 2000.

2) The technology to achieve that production level is of relatively low level and, for the most part, is currently available.

3) Renewable energy sources have been organized by the Department of Energy into three major groups:

I. Thermal (heating and cooling) applications

-heating and cooling of buildings

-heating of water

-agricultural and industrial process heating

II. Fuels from biomass

-plant matter, including wood and waste

III. Solar electric

-solar thermal electric

-photo-voltaics

-wind (windmills)

-ocean thermal electric

-hydropower (hydroelectric dams)

4) Renewable resources is a generic term based upon the unifying concept that these sources are based on solar energy, either directly or indirectly, and up to the storage age of 100 years (plant matter).

5) Renewable energy sources are most efficiently utilized in a decentralized scheme, and the majority of applications are currently on-site.

6) The fuel for renewable energies is free; the major cost is conversion equipment.

7) The 20 percent contribution for the year 2000 was calculated at a 10 million barrels of oil a day contribution towards a 50 million barrel a day equivalent of total energy consumption.

In response to the major charge by "hard-path" proponents that the choice of conservation and renewables is a choice for a stagnant, or no-growth economy that spells the decline of the current U.S. standard of living, Grossman and Daneker (1978) argued the following:

> The increased energy efficiency plus solar energy choice can provide sufficient energy for a prosperous economy. In fact, such a solution to the nation's energy problem actually leads to a more stable economy and to more jobs than does the large-scale system scenario. It does so with less pollution, less disease, less social disruption, and less interference with community, labor union and individual rights. (p. 1)

An excellent micro-level study supporting this generalized conclusion was the Bauchsbaum (1979) projections of the impact on local/regional labor markets of Long Island, New York in a scenario that substituted solar space heating and solar domestic hot water systems and their attendant retrofit technologies for the construction of a centralized, electric generating station. On a national scale, the state-of-the-art research was A New Prosperity (Kelly and Garvell 1981) produced by the Solar Energy Research Institute (SERI). The study concluded that by the year 2000, the United States could enjoy its historic high rate of growth while reducing its energy consumption by as much as 25 percent. Concurrently some 20 to 30 percent of this reduced demand could be supplied by renewable energy sources. The $800 billion investment over a twenty year period would provide this reduced energy mix and achieve a full-employment economy and increase worker productivity. It is of special interest to note that Kelly and Garvell (1981) proposed a national energy plan that would encourage these realistic investment strategies by reducing and re-directing federal expenditures in energy.

Energy Policy for the National Level

Several studies have attempted to decipher the politics of energy. Chubb (1979) argued that his case studies "demonstrate the persistent strength of narrow clientele relationships in the energy field and the inability of outside political actors to substantially weaken them." Such an assessment has been a continuing theme of Solar Lobby reports published monthly in "Solar Age". Rhodes (1980) compared the current federal policy to develop and commercialize solar energy technologies with the long-standing federal commitment to develop civilian nuclear power technology. His analysis was that federal solar policy has been largely based on the organizational and operational formats inherited from the administrative structure responsible for fission projects. The impact of this organizational scheme on federal solar energy policy has had negative effects, with the result of fragmented policy control over solar energy research. Although such studies are valuable for understanding the internal mechanisms of government support for energy-related policy, Hall's dissertation, "Energy Conservation: An Analysis of Public Policy Formulation, Implementation, and Alternatives", (1978) developed an historical overview of energy policy critical to understanding the "exhortation and education" mandates underpinning governmental support for energy education. The federal government's response to the energy shortages of the early 1970's was formulated within the following context of the predominance of energy producers' assumptions and concerns:

1) "In 1973, more than forty agencies, bureaus, and commissions had some role in energy regulation." (p. 146)
2) A review of over 100 studies of fuel and energy matters...are evidence of the fact that energy has not been viewed as an organizing concept for government." (p. 17)
3) Prior to 1973, policy studies were driven almost totally by the concern for energy supply and the discovery of new energy resources and the development of technologies which could produce them." (p. 19)

4) "Historically the association of government agencies and energy industries arose out of [1] the industries' interests beneath publicly-owned lands, and in hydroelectric sites... [2] the significance of energy resources to the federal responsibility for national defense... [3] in response to the monopolistic growth of gas and electric utilities during the 1930's, government interests broadened into the areas of economic regulation and development... [4] in the 1950's and 1960's, the federal government assumed a stronger role in matters related to health, safety, and the environment, culminating in the enactment of national legislation to control water and air pollution and the impacts of major federal decisions." (p. 166)

5) By 1973-74, national leaders recognized that "the U.S. lacked an overall energy policy", and that "what had developed was a wide range of fragmented, uncoordinated and conflicting energy-related policies." (p. 146)

6) "The only assumption for the demand side of the nation's energy system was the seemingly unquestioned concept of rapid growth." (p. 148)

7) "Restrictive [energy] programs...were not implemented specifically to conserve energy or reduce demand. Rather, they were adopted to protect energy suppliers and consumers by maintaining what were thought to be appropriate prices in the face of downward price pressures." (pp. 148-149)

From a conceptual standpoint, the U.S. had not formed a comprehensive, national energy policy by 1980. Despite the decade-long evolution of the energy policy system, the policy process remained the same, one of piece-meal, ad hoc policy formulation and implementation, reflecting conflicts in intergovernmental relations and characterized by confrontation among public and private interest groups. Policy decisions, although processed by small incremental steps, represented choices that influenced and polarized relevant partners-at-interests, highlighted opposing values, and stirred the political and social institutions already in place. The resultant series of individual decisions were triggered by specific problems, at specific times, and with little attention to the interplay of the policy pieces. The policy system slowly evolved through a variety of channels--administrative action, executive branch orders, legislative action, agency programs to meet legal mandates, federally-initiated state responses, and a host of private and public sector publications of research findings (Hall 1978).

During the 1970-1980 decade, a minimum of energy demand theory--conservation and renewable energy--penetrated this diffuse policy mechanism. However, these de facto decisions, that signalled the inclusion of conservation and renewable energy as previously free market areas requiring federal intervention and regulation, did not lead to a comprehensive national energy plan. In fact, analyses (Hall 1978; Franta 1982; Hirsh 1977; Hayes 1982; Grossman and Daneker 1978) of President Carter's national energy plan concluded that the debates between established energy supply industries and conservation/renewable energy proponents have disclosed that the apparent emphasis on conservation and solar energy is exactly that--apparent. For instance, although the year by year percentage increases allocated for solar energy research and development indicate large gains, the relative gains of solar R & D compared to fission R & D provide another picture.

The following graph illustrates this historical perspective. Under Carter's energy legislation solar monies for the 1978 ERDA budget received a cost-of-living increase to reach the $250 million level (Hirsh 1977).

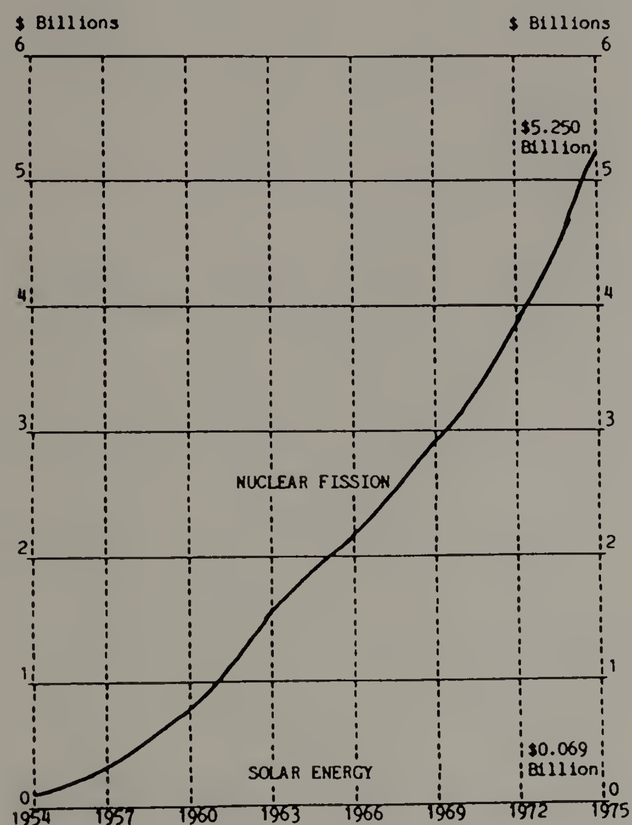

Figure 1. Federal Expenditure for Solar Energy and Nuclear Fission

Although some analysts such as Stevenson (1980) concluded that the Carter plan represented a fairly consistent set of tax incentives, grants, loans, and regulations aimed at balancing the domestic energy supply, other observers (Grossman and Daneker 1978) pointed out the decline in percentage of natural gas and oil contributions would be offset, not by renewable sources, but by increased dependence on coal and nuclear. These projections of Carter's energy plan are sharply disputed by the works of Stobaugh and Yergin (1978), Lovins (1975, 1977), and Grossman and Daneker (1978).

Table 1

Percent Distribution of Primary Energy Sources

Energy Source	1977 (Percent)	1985 (Percent)	1990 (Percent)	1995 (Percent)
Coal	19.98	24.72	30.13	35.55
Gas	25.83	21.87	18.76	15.90
Oil	47.76	42.72	38.64	34.37
Nuclear	3.39	7.16	9.10	10.79
Other	3.04	3.53	3.37	3.38
Total	100.00	100.00	100.00	99.99

Source: Adapted from Energy Information Administration, Energy Supply and Demand in the Mid-Term, U.S. Department of Energy, April 1979.

Carter's National Energy Plan represented in many respects the high point of conservation and renewable energy provisions in federal legislation. However, the impact of this demand-related policy was mitigated by several factors, not the least of which was the 1980 change in Administrations. The Reagan Administration has failed to expand on the National Energy Plan; in fact, the proponents of conservation and renewable energy feel they have a great deal to fear from the Reagan tenure. Denis Hayes (1982), a recognized national leader for the solar industry, summed up this feeling of foreboding in a recent communication to the ASES (American Solar Energy Society) membership:

> Solar interests are facing some very dark days. A large part of the current problem stems from the strong anti-solar stance of the Reagan Administration which has created a climate in which superb researchers are being forced to leave the field and fine companies are unable to acquire financing.
>
> These federal assaults are generally accompanied by pages of dubious statistics, faulty economics, and/or bad science. Unless Congress, the financial community, and the public have another source of credible information, I fear we could face consequences even more dire for the solar community--and our national well-being and security--than those we have already experienced. (p. 2)

The most cogent perspective concerning the lack of a sufficient federal commitment to conservation efforts and renewable energy source development was Franta's (1982) calculation that, "the Federal budget for renewable energy would operate the United States Pentagon for less than one hour." (p. 3)

Energy Education

What is Energy Education? The decade-long energy debate is shaping up as a crucial test for American democracy. The energy crises of the 1970's were more obvious manifestations of an international transition in the traditional balance of power. The United States and other energy-intensive, industrial nations face an end to the era of abundant, inexpensive energy. Since the turn of the century, the American economy has flourished on cheap energy supplies: when wood ran out, coal moved in; when coal proved less efficient, oil moved in. But as domestic oil supplies begin to diminish and energy costs rise, there is no new energy fix, no new technological fix ready to step in.

The challenge for the American system of democratic decision-making involves ethical issues. What energy mix and what political, economic, social, and environmental side effects are we willing to choose in order to meet energy demands. Current energy needs will have to be altered, one way or another. It is the manner in which we accept conservation that forms another of the democratic choices.

These questions raised by difficult choices have not been advertised. Instead, the decade-long national energy debate has assumed that helpful information would improve the public's understanding of energy issues and that the resultant energy awareness would lead to individual contributions and the consensus of a new, national energy ethic. The combination of individual actions as solutions and a raised level of consciousness would somehow "do the trick". Unfortunately, the public remains as skeptical and confused about the energy problem as it did in the early and mid-1970's. According to Hall (1978), the only major shift in public attitude towards energy issues appeared to be a declining level of concern.

In the early 1970's the federal government through executive directives launched a series of small, incremental responses to anticipated energy shortfalls. By 1980, federal and legislative activities had created a body of laws, regulations, and mandates that resembled, and only resembled a national energy policy. It was within this context of public disinterest and sporadic federal intervention in energy affairs that energy education emerged as an information-dissemination network.

The appearance of energy education activities during the early 1970's has proved to be anything but a coherent approach to the linking of education and energy (Akers 1980; Mason 1978; Energy Education Project 1979). The only universally shared views among the great number and variety of interest groups delivering a broad range of educational programs and services to the American public were those initial, glaring realizations that triggered the movement:

1) the United States faced an energy supply and demand crisis that represented one of the most critical challenges our nation will face during the remainder of this century;
2) all available data demonstrated that confusion and a basic lack of energy awareness permeated virtually all segments of the American public;

3) a major prerequisite to any set of solutions to the energy problem was the understanding and support of the American public.

Research conducted by the Energy Programs office of the Department of Energy (Akers, 1980) provided a broader perspective for these policy and implementation problems. The government agencies representing federal, state, and local levels, academic institutions, and profit-oriented organizations combined to form a "crowded environment" of energy education sponsors. Although Akers listed twelve agencies and departments on the federal level, he also reviewed a sample of energy-relevant federal activities from additional federal departments and concluded that the official DOE listings "underestimate the true extent of ongoing energy education" (p. 13). Furthermore, a large number of energy-producing corporations composed another group of energy education sponsors with a specific point of view, and their efforts were generally countered by public interest groups such as the League of Women Voters, the Union of Concerned Scientists, and the National Council of Churches.

The definition of energy education then remains elusive at best. "Energy education" connotes different meanings to different sponsoring interests based on their particular structures and goals. The Department of Energy (Mason 1978), for instance, found great difficulty in differentiating between:

1) "public education" and the formal education of academic institutions;

2) propaganda and education;

3) public information/consumer awareness and citizen participation in government decision-making.

A sample of other issues affecting DOE efforts to define energy education was raised by Akers (1980):

-practical skills instruction;

-contextual instruction designed to raise the level of public awareness of energy problems to include discussions of political, environmental, and economic consequences of the problem and solutions;

-contact of a variety of "publics", including senior citizens, youth, teachers, low income groups, farmers, labor and union members, businesses, environmentalists, consumers;

-regional and local relevance;

-recognition of the role of existing educational institutions;

-committment to the major goals of DOE, including increased supply of renewable and nonrenewable sources, reduced demand, equitable allocation and cost of energy.

In conclusion, current energy education activities appear to have evolved in a scatter-shot approach, generated by a plethora of self-serving interest groups, often in direct contradiction of one another, with a minimum of political supervision. The net impact of these various public awareness campaigns has resulted in continued public confusion and skepticism regarding energy problems.

The Failure to Change Public Perceptions. When a group of educators asks what education can do to help solve a problem facing the nation, it is critical to define the nature and magnitude of the problem. Addressing the issue of the "energy crisis" poses a most difficult task from a technical viewpoint. The raw data on energy resources, supplies, conversion processes, consumption, and projections for dozens of sub-categories of these constructs are enormous. The dissemination of information about these energy-related facts and forecasts creates another variable: a wide range of interest groups have been presenting information of differing degrees of quality with intents that vary widely, often in contradiction with one another. The argument of this study, then, is that the American public is not being "instructed" about energy issues; energy education has failed to educate the public. Instead, it is generating a body of information best described as "mixed messages" or "misinformation".

The first issue that needs to be addressed is the apparent failure of the wide range of energy education activities to achieve the assumed goal of transforming the public's awareness of energy issues into a new, national energy ethic. Once this fact has been established, the reasons for failure can be explored.

There were three questions Hall (1978) asked concerning the American public's understanding of the energy problem highlighted by the 1973 crisis. Hall had questions about the public's perceptions of:

1) how important was the "energy crisis" as a national policy issue;

2) why the problem existed; and

3) who was to blame.

According to Hall (1978), the Gallup poll of January 1974 proved to be the high point of public concern for the "energy crisis/fuel shortage". During this particular time frame, energy issues momentarily replaced traditional economic concerns (the high cost of living and inflation) as the top priority. This level of interest quickly subsided in 1974 and 1975, and energy concerns fell to three to seven percent, with an overall rank of third or fouth of all national issues.

In 1974, the Opinion Research Corporation (under contract to the Department of Energy) initiated a series of surveys of public attitudes towards energy problems. Among the many conclusions drawn from these surveys (Hall 1978), there appeared to be a strong skepticism about the severity of the energy problem. This view occurred "among all age, education, and income groups, and in all sections of the country". A second general conclusion based upon the same data base indicated that the oil business, the public, and the government shared the responsibility for the energy shortage. A pointed summary of public opinion was synthesized by Hans Landsberg in his journal article, "Low-Cost, Abundant Energy:Paradise Lost" --industry "conspired", government "bungled", and environmentalists "obstructed".

Lastly, since the public had little information about energy supply-demand trends, there was little public support for the belief that the growth patterns of demand had created real problems of supply, especially with regard to domestic energy sources. Table 2 indicates that the public in general, despite their individual differences of opinion regarding the severity of the shortages, supported, rather indiscriminately, seven reasons for the energy problem.

Table 2

Public Perceptions of Possible Reasons for the Energy Shortage (percent saying reason is "very important".)

Reason for Energy Shortage	Total Public	Very Serious	Not at All Serious	Environmental Activists*
Public increasingly wasteful	64	70	49	64
Too many inefficient consumer goods	59	62	44	70
Expansion of industry	55	57	54	56
No national energy policy by government	53	61	42	57
Oil companies didn't prepare	50	54	36	45
Various pollution controls	50	55	49	35
Population growth	48	55	49	53

Source: Opinion Research Corporation, General Public Attitudes and Behavior Toward Energy Saving, Vol. 1, prepared for the U.S., Federal Energy Administration (now Department of Energy) (Springfield, Va.: National Technical Information Service, September 1974), p. 6.

*Includes people who either belong to an environmental organization or have written a letter on an environmental subject to a newspaper, legislator, or other government body, or have done both.

This brief review of three areas of public perception should provide evidence that the public perception constituted a skeptical, confused, and uncertain response to the events of the early 1970's and to the subsequent "mixed-message" of public information attempts sponsored by diverse interest groups. Lovins (1975) pointedly summed up this phenomenon of self-contradiction:

> Energy promotion has led to widespread confusion between demand and need. It also supports self-fulfilling prophecy, whereby energy planners first predict a doubling of, say, electrical production in ten years and then work hard to make it come true - and complain about how difficult it is, perhaps simultaneously proclaiming "energy crisis" and "use more!" (p. 16)

The key points of this section are that energy education efforts have not changed the public's perceptions about energy issues, and that the "misinformation" or "mixed message" of energy education is a component of that failure.

PART II. Public Education's Response to Energy Issues

Public Education, K through 12

The problems that plague energy education in general are reflected directly by the barriers hindering the development of energy education activities in public schools and their K through 12 (kindergarten through twelfth grade) programs. The first problem is that of definition. Concentrating on public school K-12 activities, the Energy Education Project (1979) concluded that the difficulty in establishing an all-encompassing definition for grades K-12 energy education stemmed in part from the resistance of various interest groups to give approval to definitions that may not have coincided with their goals. Other negative forces were the perceived priority of energy education, its implementation level (from a major, comprehensive theme to a curricular supplement), lack of funds, and a generally disorganized policy structure.

Recently ECS published a booklet to answer these questions of definition, Energy Education: Why, What, and How? Bauman and Petrock (1980) stated six objectives that comprise a "definition".

1) to enable people to understand the nature and importance of energy;
2) to provide information about changing supply and demand factors for various souces;
3) to prepare people to consider the local, regional, national, and international implications of different energy sources;
4) to provide information about conservation;
5) to prepare people to make personal and societal decisions related to energy supply disruptions;
6) to prepare people for energy-related careers and to become energy conscious in other career fields.

This definition by objectives, then, addressed some of the K-12 concerns, but did not attend to all the issues raised by the Energy Education Project. The definition did not provide guidelines for evaluating subject matter content submitted by competing interest groups with conflicting goals. It also did not deal with the practical problems of implementation strategy. Energy education content in public schools was strictly informational by definition. However, according to the arguments set forth by this review of literature, this information process could not achieve its goals of "informing" the public largely because the content was "misinformation"; the next series of obstructions facing public school-oriented energy education efforts involved delivery problems. The Energy Education Project conducted for the Education Commission of the States (1979) listed the following state-level barriers to public school K-12 efforts:

- -the absence of a comprehensive national energy education policy;
- -the disparate nature of state energy agencies and policies;
- -a credibility gap concerning the existence and severity of the energy problem;
- -the tenuous support for energy-related education from both the general public and its political leadership;
- -the conflicting goals of interest groups delivering energy education;
- -the apathy of public school teachers;
- -a general lack of intra- and inter-state communication and coordination.

In summing up energy-related activities of K-12 public education, "energy education" has been a moderate program of curriculum supplement triggered by the energy shortages of the 1970's. As government, industry, and the general public responded to the late 1973 and early 1974 "energy crisis", educators began to incorporate energy materials into the public school curriculum. Curriculum materials have been promoted by a wide variety of institutional coalitions, but much credit for the integration of energy-related instruction into existing K-12 programs must be given to the grass-root contributions of classroom teachers (Kryger 1978). Despite the fact that a growing number of educators have translated their concern for the energy needs of our present and future generations of Americans into modifications of the public school curriculum, there are comparatively few schools in the United States that include energy-related information as a primary and important part of their curricula (Posthuma 1978). Therefore, on the public school level, energy-related instruction, with few exceptions, has not penetrated established curricula. The net impact of all energy-related, informational programs on the public school level has not been evaluated, but it can be assumed to be minimal.

The reasons for this limited impact are multiple. However, the single problem of self-contradictory information cannot be underestimated. Even if successful delivery systems were operative, the subject content of the curricular components could be labeled "misinformation."

Vocational Education

In moving towards an estimation of the energy education-industrial arts intersection, it is appropriate to review vocational education's response to the national energy problem as provided by the AVA (American Vocational Association) Energy Project and one of the

Energy Project's Advisory Committee members, K. Ertel. The significance of such leadership response is based upon several factors: first, in terms of federal legislation and federal funding, industrial arts was identified as a sub-set of vocational education; secondly, because of its broader funding base, vocational education's leadership has directed more resources--educational leaders' time and talents, funding, etc.--towards its response to energy issues than has the leadership of industrial arts; and lastly, the AVA Energy Project specifically addressed the role of industrial arts in meeting energy issues.

The first hurdle, as was the case with energy education both overall and in the realm of public education, is the problem of definition. The pressures resulting from the lack of comprehensive energy education policy and programming were exemplified by Ertel's (1980) operational definition of vocational energy education that reflected three considerations:

1) Given the absence of appropriate national policy, the implication was that vocational education had to assume the responsibility for defining its own energy-related policy.
2) Given vocational education laws, practices, and institutional constructs, the definition had to be consistent with historical mainstreams and present laws.
3) Given the current national energy plan and the local level efforts to infuse energy education components into regular programs, the definition had to recognize both the macro and micro contexts.

In other words, Ertel's definition could not be related to comprehensive K-12 or K-lifelong programming. Ertel's definition (1980) created a position statement further differentiating vocational education activities from general education K-12:

> Vocational energy education is for work related to increasing the energy supply, to utilizing energy resources efficiently, or to conserving energy. Its purpose is to help students develop related skills, abilities, understandings, attitudes, work habits, and appreciations. It is taught in all vocational education programs at all levels. (pp. 20-21)

The "retrofitting" of present curricula implied by this definition would produce skilled workers who have an understanding of energy use, supply, and conservation, and who also would be trained in energy-related skills in each occupation. In other words, vocational energy education would include both "energy literacy" and energy-related skills training. The argument arises, quite logically, that "energy literacy" could conceivably be delivered more effectively by general education programs on awareness and orientation levels.

The AVA Energy Awareness Project (1980) focused on the question of how vocational education could gear up to meet emerging energy-related training demands. An assessment of working force needs in the field of energy was conducted by the Project Committee. The related literature did not provide firm projections for future employment needs. Ertel's (1980) review of the same sources led him to conclude that instead of technicians trained for specific new energy technologies, vocational education needed to train more HVAC (heating, ventilation, air conditioning) technicians, carpenters, plumbers, sheetmetal workers, boilermakers, and various mechanical technicians. In terms of vocational education's curricular and programming modifications to train these technicians, Ertel (1980) suggested that vocational education did not need to create new programs for emerging energy industries, but rather that vocational education needed to "retrofit" its present curricula, to include in its traditional technicians' training programs "energy literacy" across the board and job-specific energy-related skills for appropriate trade areas.

The implication of vocational education's response to energy issues was that energy education was most appropriate in terms of energy literacy as well as specific job skills. Industrial arts would qualify as a pre-vocational delivery system for energy literacy even as it presented energy education to all of its students.

Industrial Arts: The Context of Current Goals and Delivery Structure

Industrial Arts Education in America evolved from a "pedagogically organized system of manual skills training" and was defined as a separate subject or curriculum area by Bonser in 1924. Bonser's definition stressed that students as members of an industrial society should experience the roles of producers before they entered society as adult consumers: industrial arts are "those occupations by which changes are made in the forms of materials to increase their values for human usage...and of the problems of life related to those changes." During the 1920's, 1930's and 1940's, industrial arts curricula were built upon two foundations (Andrews 1976). The first was the dependence upon the shop "project" as a vehicle for combining academic and skills training. The second was solidification of a system of seven separate craft areas--graphic arts, woodworking, mechanical drawing, metal working, mechanics, drafts, and electricity\electronics.

In the late 1950's and throughout the 1960's and 1970's, industrial arts leaders repeatedly refined the definition of Industrial Arts Education as part of a series of innovations in Industrial Arts teacher-training programs. Andrews (1976) outlined the historical evaluation of these innovative programs and reviewed their rationales, goals, objectives, and exemplary curricular efforts. Traditional craft areas--graphic arts, woodworking, etc.--were subsumed under a variety of reorganizations based upon industrial themes, historical perspectives, technological matrices, and problem-solving strategies. Included in this nation-wide restructuring were the "Unit Method", the "Maryland Plan", "Maine State Plan", "Functions of Industry" program, "American Industry Project", "Orchestrated Systems", "Industrial Arts Curriculum Project", and "Industriology".

Despite the abundance of innovative programming, Andrews (1976) concluded that these "revolutions" have failed to achieve wide acceptance and their impact on the traditional industrial arts curriculum has been relatively small. Pressures from outside the profession have also attempted to modify industrial arts programs. Career education, the U.S. Office of Education's occupational clusters, special education, vocational-special education, the category-status of industrial arts under federal vocational education legislation have all introduced potential curriculum modifiers for industrial arts programming. But more recent evidence (Standards Project Staff 1979) indicated that skills training in traditional shop areas remained predominant.

Lindbeck (1972), arguing from another historical perspective, stated that since the 1930's industrial arts leaders have attempted to reduce the definition of industrial arts to unique and defensible objectives. Lindbeck traced the lineage of the five goals for industrial arts set forth by the revised AVA Industrial Arts Guide (1968) starting with the 1934 sub-committee report (AVA, 1934). The twelve goals of this report synthesized a "hands-on" and "work attitude" approach espoused by a series of earlier AVA committees. The 1946 report of a similar industrial arts sub-committee (AVA, 1946) continued these themes, but reduced the number of goals to nine. According to Lindeck (1972), since there was little objective evidence that the items of attitudinal change--pride in achievement, self-discipline, appreciation of good design and the like--were in fact taking place, educational leaders attempted to reduce the scope of the profession to defensible and tenable parameters. The Office of Education study, "Improving Industrial Arts Teaching, A Conference Report" (1960) focused on objectives that could realistically be achieved in industrial arts settings:

1) To develop in each student an insight and understanding of industry and its place in our culture.
2) To discover and develop talents of students in the technical fields and applied sciences.

3) To develop technical problem-solving skills related to materials and processes.

4) To develop in each student a measure of skills in the use of common tools and machines.

By 1968 the AVA Industrial Arts Guide (1968) represented a further refinement of these earlier goal statements and set the theme for the direction of industrial arts programming for the decade of the 1970's:

Goal I - Develop an Insight and Understanding of Industry and Its Place in Our Culture.

Goal II - Discover and Develop Talents, Aptitudes, Interests, and Potentialities of Individuals for the Technical Pursuits and Applied Sciences.

Goal III - Develop an Understanding of Industrial Processes and the Practical Application of Scientific Principles.

Goal IV - Develop Basic Skills in the Proper Use of Common Industrial Tools, Machines, and Processes.

Goal V - Develop Problem-solving and Creative Abilities Involving the Materials, Processes, and Products of Industry.

Since the preceding goal identification process re-emphasized the priority of manual skills training, Lindbeck (1972) addressed the classical question of what is the difference between industrial arts and vocational education. Lindbeck made the general distinction that industrial arts prepares youth to live in contemporary industrial society and vocational education prepares youth for gainful employment. However, Lindbeck stressed the point that industrial arts programs had to be flexible in order to meet the needs of the community it served; in other words, some industrial arts programs may be more or less vocationally-oriented, career-oriented, or general education-oriented, depending upon community concerns.

The predominance of manual skills training for industrial arts programming during the 1970's as presented by Andrews and Lindbeck was more recently reaffirmed by a survey of 2,235 public secondary schools conducted by the Standards for Industrial Arts Programs project Staff (1979). The goal statement, "develop in each student a measure of skill in the use of common tools and machines", ranked first, and the overall goal priority ranking results led to the Project Staff's conclusion that there appeared to be little change in the philosphy of industrial arts during the 1960's and 1970's.

The Intersection of Energy Education and Industrial Arts

Given the confused picture of energy education and the tenacity of traditional industrial arts programs to retain their skills training approach in craft-area shops, it comes as little surprise that the intersection of these two educational components is minimal with regard to educational planning policy and skeletal with respect to curriculum modification. Searches of dissertations (1974 to present) and reviews of appropriate journals ("School Shop", "Industrial Education", and "Voc Ed") indicated that industrial arts professionals gave little attention to the policy/planning aspects of industrial arts--energy education linkage. However, classroom teacher presentations outlining shop projects using energy-related technology averaged one article per month for the above journals. These project plans rarely addressed major issues central to energy education and, instead, focused on the appropriateness of a particular energy-related device as a shop (e.g. welding, woodworking, electronics) project.

The quantitative data for describing this energy education--industrial arts intersection would be difficult to acquire and to assess for several reasons:

1) the lack of a universally recognized definition of energy education;
2) the multiplicity of energy education funding sources;
3) the disparate nature of state-level agencies responsible for energy education; and
4) the inappropriateness of traditional reporting channels.

The acquisition of this type of data is far beyond the resources available to this type of study.

The direction for this study, then, is to pursue a perspective from which industrial arts leaders can make policy decisions and to provide data for decision-making consistent with the national-level need to meet the energy challenge. One motivation for this pursuit stems from evidence (Kleinbach 1981 and Gierke 1982) that industrial arts programs may be one of the most effective delivery systems for energy education, once energy education can be defined as a philosophically-consistent information base.

PART III. Educational Change: Bridging the Knowledge Gap

A New Definition: Renewable Energy Education

The major point for this study is that the majority of energy-related education studies (AVA Energy Education Project 1980; Ertel 1980; Seum 1980; Energy Education Project 1979; Edington 1977) indicated the need for a comprehensive, national energy policy. The preceding historical review concludes: 1) that the policy system has only recently selected alternate policy choices offered by proponents of energy-demand orientation, and 2) that the policy system framework has only evolved in small, fragmented, single-issue oriented steps. The Carter energy plan was the most extensive federal action to date, but nevertheless, it did not formulate an operational national energy plan.

A similar need for a comprehensive, national education plan was expressed by the Energy Education Project (1979):

> Before a new national energy ethic can be instilled in the public by traditional education systems, relevant policies must be developed at state and local levels to guide key educators and legislators in the implementation of comprehensive K-12 energy education programs. (p. 12)

Missing, too, is a recognized definition of energy education. Ertel (1980), the AVA Awareness Project (1980), Energy Education Project (1979), and the Commissioners of Education, Boyer (1978) and Smith (1980), all expressed the need for this unifying structure. Given the critical issues of a definition for energy education and the current policy system, this researcher proposes an operational definition of energy education that assumes a public dissemination system involving public education (K through community), including vocational education and its major sub-categories, industrial arts and home economics, and community education activities sponsored by adult education programs, extension services, credit or non-credit post-secondary programs, or by any other educational delivery system targeting the general public (e.g. public utilities). The proposed definition is distinctive in what it does not include.

A. Energy education is a comprehensive, fully-integrated program in all public education programs (K - community education), including:

1) curriculum modifications at all levels and in all disciplines;

2) energy awareness education for all public school employees;

3) mandated energy conservation and retro-fit measures for all facilities.

B. Energy Education activities on the orientation and awareness levels should develop the following "energy literacy" concepts:

1) exponential growth and finite energy resources;

2) demand/supply projections for conventional, finite energy resources;

3) social, political, environmental costs of conventional/ unconventional and domestic/foreign finite energy resources;

4) definitions of the three types of conservation;

5) renewable energy resources - advantages and social benefits;

6) decentralized, renewable energy resources - advantages and social benefits.

C. Energy Education on the implementation (skills training) level should be drawn from technically appropriate activities in:

1) conservation and energy retrofitting:

2) decentralized, renewable energy sources.

The implications of any one, standard definition for energy education would be considerable just as a baseline for communication, policy responsibility, funding criteria, and program design, delivery, and evaluation. The above definition is intended to disconnect the traditional energy suppliers' access to the current legislation and activities associated with energy education in the broadest sense. The subsequent arguments of this section support this definition of energy education. For purposes of discussion only, these arguments are divided into four separate areas: public perception, K through community structure, job training, and "soft-path" energy strategy.

Lastly, this definition was derived after reviewing the work of a political scientist, Hall (1978), and an economist, McDaniel (1979). Hall's "issue systems framework for the analysis of public policy" and its supplement, a five-critia evaluation of alternative policies, provided a framework for logically challenging accepted parameters of norms and options for counteracting the pressure to abide by current practices, program requirements, traditional funding sources, and other assumed criteria that obscure options or alternatives for decision-making. The "issue systems framework" and the evaluation criteria formed a values-oriented decision-making process. The soft-energy path is a conscious value choice; it involves ethics, morals, in the present and future tense (Lovins 1977). Once the baseline assumption bases were defined regarding the energy problem, the choice between traditional energy supply growth theories and demand-oriented, conservation and renewables theories was self-evident. The proposed definition of energy education was a logical extension of that alternate choice.

Public Perception. The first, major rationale for this definition of energy education is derived from the fact that it actively supports one of the two major assumption bases that have continued to collide in the policy- making arena. Conservation and decentralized renewable energy are systematically elevated as the most attractive--economically, socially, environmentally--alternatives offered to a values-oriented policy evaluation system. The impact of an energy education information base may be dependent upon the consistency "or reliability" of the information, not necessarily the "validity" of the information. The history of energy education recognizes the multiplicity of sponsoring agencies and the "mixed message" of single information bits and the "mixed message" of the totality of the data.

Bartlett's "Forgotten Fundamentals of the Energy Crisis" (1977) reviewed the principles of exponential growth, and based upon these principles, Bartlett categorized single bits of misinformation into four categories. One example of each is given here as an illustration of the deceptive nature of self-serving marketing techniques:

1) Qualitative Horror Stories - those in which we are given bland general assurances that there is no energy crisis or we are given sweeping, optimistic assurances about the sufficiency of our reserves of fossil fuels. These assurances are given without sufficient data to allow them to be checked." (p. 18)
E.g. The New Republic in an editorial, "The Moral Equivalent of Verdun" (April 14, 1979) said:
"The land on which (President) Carter built his energy house is the notion that we are rapidly running out of oil and natural gas. That wasn't true two years ago and it isn't true now."

2) Quantitative Horror Stories - those in which data are offered in support of optimistic conclusions but the data are sufficient to warrant pessimism or even to prove the conclusion to be wrong. (p. 18)
E.g. An advertisement by Mobil (1979) suggested this:
"Picture all the natural gas America has produced in its entire history. Now picture twice that amount. We think there's that much waiting to be found. Under U.S. soil, Beneath U.S. waters."

3) Backward Horror Stories - those in which learned people look at the facts and then draw conclusions that are the exact opposite of those that would seem to be dictated by a logical study of the facts. (p. 18)
E.g. William Simon, energy advisor to President Ford, on an August 31, 1977 CBS television special:
"We should be trying to get as many holes drilled as possible to get the proven oil reserve."

4) Super Horror Stories - qualitative, quantitative or backward horror stories that originate from people with highly specialized scientific backgrounds or who have easy access to excellent technical advise. (p. 18)
E.g. President Nixon urged the American public on November 7, 1973: "Let us pledge that by 1980 under Project Independence, we shall be able to meet America's energy needs from America's own energy resources."
E.g. Presidential Candidate Ronald Reagan on the August 31, 1977 CBS special on energy said: "We don't have a shortage of energy, we have a surplus of government."

Given a consistent energy education presentation of exponential growth and finite energy sources, the public should develop the understanding of concepts to refute the inaccuracies of specific information bits. The consistent bias of the proposed energy education information base would also alleviate the "mixed message" impact of the totality of energy-related data. Seligman, a clinical psychologist and therapist, in his text, Helplessness: On Depression, Development, and Death (1975), hypothesized that a person calculates four kinds of probabilities: 1) explicit pairing, 2) explicit unpairing of a response with an outcome, and differential reinforcement of other behavior as a, 3) pairing, or 4) unpairing--in order to compute an overall estimate of the contingency. In other words, we "think" this way: I do this, I don't do this, and something happens; I do this, I don't do this, and something else doesn't happen. Bisecting this quadrant of analysis is the line of an angle that means no matter what I do or don't do, something will happen or something else won't happen. The effect of this realization or calculation is the feeling that events are uncontrollable, that we can't do anything about them. Furthermore, Seligman hypothesized, that this "learned helplessness" results in three debilitations:

1) a loss of motivation, of adaptive behavior repertoire;
2) a disruption of cognition, of the ability to learn as well as a distortion of perception;
3) emotional disturbances.

The application of Seligman's theory to the American public's response to a nearly decade-long cacophony of promising/foreboding energy-related misinformation and reasuring/disappointing energy-related misinformation and reassuring/disappointing energy-related, economic realities may be an appropriate social psychology tool for interpreting the public's continued confusion and apathy concerning energy issues. Pursuing further the theories and extrapolations of learned helplessness does not lie within the parameters of this paper, but Seligman (1975) also defined predictability and unpredictability by the same theoretical constructs used in the controllability/ uncontrollability hypothesis. The graphical representation was the same. Presented below is an adaptation of Seligman's probability graph. If the X-axis represents information dealing with energy-related data in a positive, or steady growth scenario with a value range from 0 to 1, and if the Y-axis represents information dealing with energy-related data in a negative, or exponential growth versus finite energy sources with a value range from 0 to 1, then the public's perception of the probability of the severity of an energy problem would tend to fall along the perpendicular bisector. In other words, according to the public's perception, there would not be any predictive relationship between positive and negative information and the severity of the energy problem. Or, energy-related information does not give any information, one way or another, about the energy problem.

The ramifications of this hypothesis are fascinating. However, the point to be made here is that a biased energy education program would encourage a positive correlation between energy-related information and the energy problem according to the public's perception. The public's perception of the existence and severity of the energy problem is the foundation of any policy attempt to mobilize a new national energy conservation ethic.

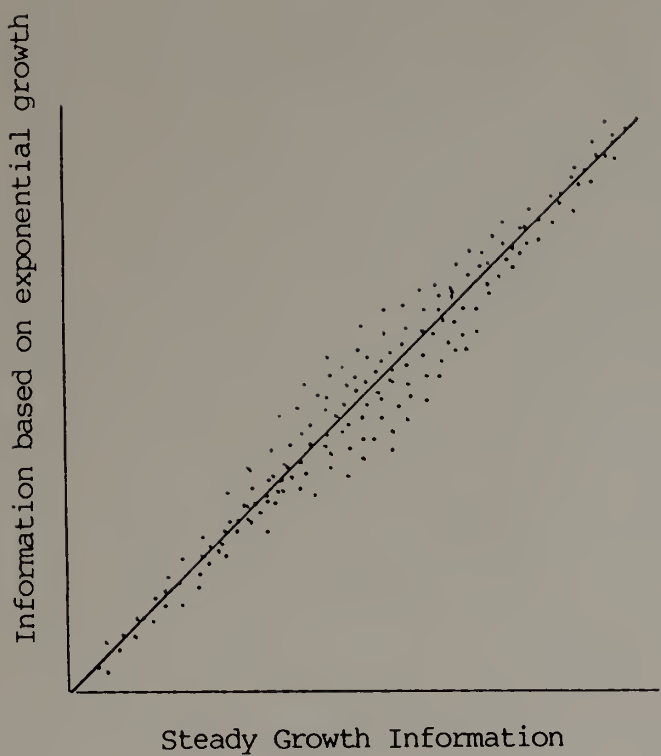

Figure 2. Public Perception of the Nation's Energy Problem

The Need for a Comprehensive (K through Lifelong) Structure. A second major aspect of this renewable energy education definition is that public schools have the responsibility to include energy-related topics at all levels and in all disciplines where appropriate as part of a comprehensive, fully-integrated program starting at the kindergarten level and continuing through adulthood.

Copa and Irwin (1979) suggested that energy education should be considered a basic educational theme with a curriculum providing energy-related awareness, orientation, and exploration and preparation. The parallel can be drawn that energy education should be developed along the lines of career education, complete with a K through lifelong hierarchy of objectives and delivery systems and also with a major collaboration between public education, government, labor and business.

One of the failings of current energy education activities is that there is little articulation between disciplines and grade levels (Energy Education Project 1979). The interdisciplinary linkages between major discipline areas (for example, social sciences, sciences, English) and secondary programs (home economics, industrial arts, vocational education) are also minimal (Posthuma 1978). The present delivery system for energy education basically depends upon the interest level of individual teachers. There are few coordinated, school-wide programs.

Job Training. While there seems to be excellent curriculum materials developed for "energy literacy" K-12 (Blackman 1980; Kryger 1978; Posthuma 1978), vocational education (Ertel 1980; AVA Energy Awareness Project 1980) has focused on the question of how vocational education can gear up to meet emerging energy-related training demands. The proposed definition of energy education sharply reduces the range of "energy-related training" demands by eliminating job market analyses of conventional and unconventional finite energy source industries, and centralized renewable energy industries. In other words, the fore-casting of labor needs and skill training needs in power plant construction, nuclear power plant operation, coal mining and transportation systems, synthetic fuels industries are not correlated with energy education.

The policy recommendation is based on the principle of consistency: if "energy literacy" concepts support conservation and decentralized, renewable energy, then the implementation or skills training component of the comprehensive program must reflect the selection of that policy alternative. Secondly, the conclusions of labor market demand experts indicate that forecasting labor demands for emerging new technologies is extremely difficult and that the majority of energy-related training should be done in the context of traditional trade practices.

Seltzer (1979), Manpower Assessment Program, U.S. Department of Energy, stated that job creation is tempered by two factors:

1) As new jobs emerge during the "handicraft stage" of a new technology, engineers and technicians double-up to handle production and installation activities.

2) As new jobs are formalized, the challenge for education is to teach new skills to traditional tradespeople in present programs where appropriate or on-the-job.

Information for the post-secondary level elicited similar conclusions about modifying present curricula. In the first half of the 1970 decade, two-year technical institutes and community colleges responded rapidly to perceived demands in new energy-related technologies. At the 1976 Energy Technology Training Conference, co-sponsored by the U.S. Energy Research and Development Administration and Development Administration (ERDA) and the American Association of Community and Junior Colleges (AACJC), educational leaders provided growth projections for new technology programs and modified traditional programs. However, Mahoney (1980) concluded otherwise. From his review of a series of national studies covering a six-year period, Mahoney discovered that despite earlier projections of substantial increases in the number of energy-related programs, the number of degree and certificate programs offered by junior/community colleges had remained stable by 1980. There was, however, a sharp increase in the number of non-credit workshops and courses offering energy-related skills.

Ertel (1980) concluded in his monograph for the AVA Energy Awareness Project that vocational education did not need to create new programs for emerging energy industries. Ertel argued that vocational education needed to "retrofit" its present curricula, to include in its traditional technicians' training programs energy literacy across the board and job-specific energy-related skills for appropriate trades areas.

The qualitative interpretations of the labor market studies for decentralized renewable energy sources, in particular solar heating and cooling and conservation, provided a picture of the integration of new skills in traditional trade areas. Levy (1980) reported in the "Solar Energy Employment" manpower survey and forecast sponsored by the Office of Education, Business, and Labor Affairs and the Office of Solar Applications, U.S. Department of Energy and compiled by Battelle Columbus laboratories. His conclusions were interesting for several reasons:

1) The solar manpower pool was underutilized in terms of hours-per-week spent on strictly solar activities--30 hours on the average.
2) The categories of occupations that employers found to be most difficult to hire--engineers, atmospheric scientists, systems researchers, and college instructors--were from highly-technical levels.
3) Only one of four employers felt that professional, technical, and skilled employees were required to apply skills substantially different from the skills required of traditional non-solar tasks.
4) Over sixty percent of the technical employees felt that they needed additional training to work in solar, but the nature of this updating was the application of traditional content areas to solar problems.

Levy's research introduced the concept that solar and conservation technology's labor demands coincided with the technical level of vocational education programming. Ertel (1980) concluded that instead of technicians trained for specific new energy technologies, vocational education needed to train more HVAC (heating, ventilation, air conditioning) technicians, carpenters, plumbers, sheetmetal workers, and boilermakers, and various mechanical technicians. Maloney (1980) specifically addressed the "employment-growth" scenario of a heavy concentration on solar energy and conservation outlined by Bauchsbaum (1979):

> ...the direct jobs which would be created by the implementation of this scenario (conservation coupled with solar energy use) would be those for which secondary vocational education and two-year post-secondary technical and community colleges are well-suited. They include: home improvement workers, insulation installers, carpenters, plumbers, sheet-metal workers, and heating, ventilation and air conditioning workers. (p. 14)

The community/continuing education aspect of the K-lifelong policy recommendation appears to dovetail with both the consumer and adult training/retraining needs of conservation and decentralized renewable energy technologies. Mahoney (1980) and the ERDA - ACCJC sponsored conference (Energy Conservation Workshop 1976) interpreted the important increase in less-than-degree/certificate programs as indicative of the appropriate match between community-level energy education and the role and scope of the traditional community college system. Even the most cautious researchers (O'Connor 1980) of the Solar Energy Research Institute (SERI) recognized the potential for a great range and quantity of solar courses and programs on the post-secondary level. The key recommendation by O'Connor was that training for new skills had to be based on the availability of jobs as determined by conscientious local/regional research by local advisory committees. Similarly Kenick's (1978) "Energy Teaching Center" concept targeted school age children, parents and homeowners, and teachers for community-oriented, energy-related instruction in energy concepts and hands-on experiences with conservation/retrofit strategies and alternative energy. The need and design of the curriculum would evolve through community communications. Similarly the AVA Energy Awareness

Project (1980) offered vocational education expertise in delivering adult education courses for job re-training, self-help skills and information for consumer application.

The relatively unexplored area of research (Christensen 1980) involving methods of changing consumers' lifestyles, specifically with regard to energy conservation, has been translated loosely into an assumption that public education is an appropriate vehicle for teaching the public about energy conservation, or at least making the public "aware" of energy problems. But whether or not this generalized "teaching about energy" does in fact correlate, or cause changes in lifestyle, is an open question. Christensen (1980) concluded that "given the right program", the public will take positive action through education to conserve energy. This implementation level of learning is central to the concept of "changing lifestyles to conserve energy". So is the definition of "the right program." Given Christensen's description of the model energy-related adult education programs that proved successful, it would appear that programs as envisioned by the AVA Energy Awareness Project (1980), Kenick (1978) and Maloney (1980) would be successful in providing "hands-on" experience.

"Soft-Path" Energy Strategy. Given the multitude of barriers--attitudinal, historical, economic, and institutional--to investments in conservation and renewable energy sources, a brief list of those factors linking soft-energy strategies with the proposed support of redefined "renewable energy education" is outlined below:

1) Since conservation is a decentralized phenomenon and not a single high-technology "fix" that focuses the nation's resources on one project, it will require information and implementation efforts on individual and local levels (Yergin 1979; Kelly and Garvell 1981; Kenick 1979; Christensen (1980).
2) Conservation is not a glamorous task; it is a mundane undertaking on the micro-level requiring the efforts of individuals as home-owners, consumers, and tradespeople (Yergin 1979; Kelly and Garvell 1981).
3) Residential, commercial, and industrial customers must be reeducated in terms of expectations for fast rates of return, in order for renewable energy technology to compete with conventional subsidized fuels (Christensen 1980; Maidique (1979; Kelly and Garvell 1981).
4) As a new industry, the renewables industry is fragmented and, therefore, in need of marketing systems (Maidique 1979; Christensen 1980).
5) Traditional labor forces (both current and future) need to be "retrained" to meet the demands of the renewables industries (Maidique 1979; AVA 1980; Ertel 1980).
6) A permanent, non-threatening information and education campaign should be instituted about the problem of imported oil and the possibilities of soft energy strategies (Lovins 1977; Yergin 1979; McDaniel 1979; Hall 1979).

7) Since buildings (including public school and educational institution facilties) involve the greatest number of decision-makers, conservation and retrofitting of existing structures and energy-efficient design for new construction are required; energy education can utilize school buildings as laboratories (Smith 1980; Rhyne 1980; Hansen 1979; Boyer 1978; Hicks 1978), as well as provide direct information/skills training.
8) A nationwide system of "Energy Extension Service" program (in addition to current, traditional educational systems) is needed to provide energy audits, information, and skills (Yergin 1979; Kenick 1978; Hall 1978).
9) Foresters, farmers, and businessmen need to be alerted to potentials in biomass through appropriate information systems (Yergin 1979).

Renewable Energy Education in Support of Industrial Arts

A possible interpretation of the intersection of industrial arts and energy-related intruction is that industrial arts as a discipline has retreated into the status of a narrowly-oriented delivery system providing skills training based on singular, separate projects in distinct craft areas. The objectives of providing students with larger, intellectual perspectives as encouraged by a wide variety of innovative programs have been minimized. Perhaps the responsibilities of industrial arts within the context of the proposed definition of energy education would reinforce several directions positive to the development of industrial arts as a discipline working with other disciplines to educate young people. Below are listed possible roles/ responsibilities for industrial arts programming:

1) Industrial arts would bridge the orientation/awareness levels with skills training commensurate with energy literacy goals.
2) Industrial arts would function as a required pre-vocational experience providing "energy literacy" instruction for vocational education candidates.
3) By sharing responsibility for energy-related, hands-on instruction, industrial arts would acquire interdisciplinary communication channels.
4) Given the energy conservation/retrofit strategies for physical plants, industrial arts would actively engage in the process of energy auditing, monitoring, construction and maintenance of school buildings as implementation experiences.
5) Given the community education mandate, industrial arts facilities would serve as community/adult education laboratories.
6) Industrial arts would provide a strong consumer and homeowner educational experience.
7) Industrial arts would address the need for energy-related career awareness.
8) Industrial arts would encourage "projects" designed to fit into larger efforts of energy conservation and retrofitting, including classrooms and school buildings, themselves, as the "projects".

9) Given the sophisticated, but accessible technology of energy conservation/renewable sources, industrial arts would function on upper grade levels as a pre-engineering experience.

10) The inclusion of "humanistic technology" concepts would complement energy-related hands-on experiences.

The Blueprint for Change: The Wolf-Welsh Linkage Model

Wolf (1984) characterizes change as the successful linkage of knowledge between knowledge producers and knowledge users. Knowledge is a term that denotes process, product, or ideation. New knowledge may or may not become a successful innovation based on two general conditions: first, the intrinsic value of the new knowledge relative to existing knowledge, and secondly, the selection process itself. Wolf argues that the selection process is authored by "linkage agents" and that the differential consequences of linkage agents' actions outweigh the intrinsic value of new knowledge. Linkage agents have successfully introduced knowledge spanning the spectrum from positive change to negative change.

In his monograph, "Linking Knowledge Production and Needs of Knowledge Users", Wolf (1983a) provides a) a perspective of social change theory and its sub-set, knowledge diffusion/utilization theory, b) a review of the identification of variables that affect this sub-set and c) a description of two researched-based tools designed to assist linkage agents. As Wolf points out, four groups of theoretical models of knowledge diffusion/utilization have been identified from the literature by Havelock (1969):

Model A. The Problem Solver Model.

Model B. The Research Development and Diffusion Model.

Model C. The Social Interaction Model

Model D. The Linkage Model

In addition to these generalized theoretical models, there has been much disciplined inquiry aimed at identifying and differentiating the variables that lead is change. Wolf reviews five research efforts that generated sets of variables, and notes that despite their independent status and diverse discipline orientation, these five culminating sets share common variables. Secondly, Wolf describes research efforts that sequence variables and address the problem of weighing variables and measuring their interaction effects across contexts.

Building upon this review of literature, two researchers from the University of Michigan, Welsh and Thayer, and two researchers from the University of Massachusetts at Amherst, Wolf and Hutchinson, focused on the task of providing potential linkage agents with two sets of information. First, they attempted to make available to linkage agents a progress report on knowledge utilization/diffusion empirical research that would make such relevant work accessable to that group (Thayer 1981, Welsh 1976). Secondly, they attempted to engineer a diffusion/utilization modus operandi that would bridge the gap between theory and practice (Wolf 1973, 1978, 1979; Hutchinson 1975). The impetus of these efforts to translate research into blueprints for knowledge linkage culminated in 1) the specification of variables and processes, 2) a metamethodology or modus operandi for addressing variables and processes, and 3) the sequencing of the progressive series of outcomes of the methodology.

In the words of Wolf (1983a) these three objectives were conceptually combined to answer the needs for an accessible instrument for use by linkage agents that would combine appropriate variables, processes and outcomes--an instrument that works like a recipe.

> E.g.: Think of baking a cake as an appropriate analogy. Certain ingredients (variables) and certain directions (processes) are specified in a recipe for preparing an angel food cake. Once the recipe has been proven effective (that is, delicious angel food cakes are produced), the recipe can be used by many people with reasonable success. Someone had to specify the ingredients (variables) and directions (processes) needed to produce an angel food cake. Someone must follow this same procedure--that is, select appropriate variables and processes--to resolve diffusion/utilization problems. (p. 15)

The recipe, itself, was generated through the efforts of Welsh and Wolf based upon Wolf's (1973, 1978) conceptual framework for addressing practical problems of communication and the conceptual framework of T.E. Hutchinson's procedure called metamethodology that was used to construct specific methodologies that could be characterized as:

1) systematized - this term indicates that there is a logical sequence for the individual steps in the methodology.
2) standardized - this term indicates that different agents, using the same methodology, can apply the same set of rules and procedures.
3) operationalized - this term means that the rules and procedures are stated with sufficient specificity in the

methodology so that different agents will interpret them with uniform comprehension.

Welsh's (1976) dissemination methodology was developed and partially field tested. Following modifications to the conceptual base of the dissemination methodology and further informal field testing by five doctoral students from the University of Massachusetts at Amherst, revisions of the methodology were initiated in 1978 and were completed by 1980. The resultant "recipe" (Wolf 1983a) was entitled the Wolf-Welsh Linkage Methodology (hereafter designated WWLM), and its nine primary steps (and number of sub-steps) are listed below:

I. Attributes of Persons Apt to Use the Linkage Methodology Effectively (six steps).

II. Identification of a Targeted Audience's Need to Modify Some Aspect or Aspects of Professional Practice (five steps).

III. Identification of Practices and/or Products Apt to Meet Identified Target Audience's Needs (two steps).

IV. Selection of Practices and/or Products Apt to Meet Identified Target Audience's Needs (four steps).

V. Modification of Practices and/or Products Selected to Meet Identified Needs of Targeted Audience (three steps).

VI. Determination of Demographic Characteristics and Certain Attitudes (Toward the Plan to Modify Some Aspect of Aspects of Professional Practice of the Targeted Audience (three steps).

VII. Conceptualization and implementation of Strategies and Tactics intended to incorporate Designated Practices and/or Products within the Professional Practice of the Targeted Audience (three steps).

VIII. Part One. Evaluation of the Modification in Practice (three steps).

Part Two. Evaluation of the Methodology (one step).

IX. Recommendations for Improving Upon the Linkage Methodology (steps I through VIII) on the Basis of Evaluation Results (Offered by Persons who Used the Methodology) (four steps). (p. 19)

The WWLM was formulated from research culled from half a dozen disciplines, but Thayer (1981) determined that the twenty-six generalizations that comprise this multi-discipline conceptual framework were paralleled in twenty-three cases by educational research. Despite Thayer's conclusion that the educational diffusion/ utilization research tradition is comparable to that of other disciplines, he could not rely upon the primitive level of research methodology of education-based studies to ascertain the level of applicability of the Wolf Welsh instrument. Wolf (1983a) lists four qualitative and limited field tests of the WWLM, but he suggests that more systematic field applications are required to further measure the strengths and seficiencies of the methodology, especially in various environmental settings.

The strength of the WWLM cannot be underestimated as a frame of reference for disciplined inquiry. In one concise instrument, variables are identified and sequenced, procedures are scheduled with appropriately spaced checkpoints, and periodic evaluation guarantees the consideration of realistic alternatives routes and stopping points to avoid failure.

For the specific purposes of this study, the WWLM assists 1) in providing a perspective for educational change, 2) in establishing the needs analysis as the first major step of the knowledge production/utilization linkage efforts and 3) in providing continuity to the study, especially in terms of suggestions for further research and for continued linkage efforts by the industrial arts leadership in the State of New Hampshire..

Step I: The Satisfactions of Criteria A. - F. The stage is set then for the identification of those primary sections and their respective sub-steps that will be addressed by this study. The outline of the nine major sections that comprise the WWLM (Wolf 1983a) are listed below; sections that concern this study are Section I, Section II, and Section VI:

I. Attributes of Persons Apt to Use the Linkage Methodology Effectively.

II. Identification of a Targeted Audience's Need to Modify Some Aspect or Aspects of Professional Practice.

III. Identification of Practices and/or Products Apt to Meet identified Target Audience's Needs.

IV. Selection of Practices and/or Products Apt to Meet identified Target Audience's Needs.

V. Modification of Practices and/or Products Selected to Meet Identified Needs of Targeted Audience.

VI. Determination of Demographic Characteristics and Certain Attitudes (Toward the Plan to Modify Some Aspect or Aspects of Professional Practice) of the Targeted Audience.

VII. Conceptualization and Implementation of Strategies and Tactics Intended to Incorporate Designated Practices and/or Products within the Professional Practice of the Targeted Audience.

VIII. Part One. Evaluation of the Modification in Practice.

Part Two. Evaluation of the Methodology.

IX. Recommendations for Improving Upon The Linkage Methodology (Steps I through VIII, on the Basis of Evaluation Results (Offered by Persons who Used the Methodology). (p. 19)

The section comprising Part I, "Attributes of Person Apt to Use the Linkage Methodology Effectively", describes the requisite skills and measures related to knowledge production/utilization problem-solving that the potential linkage agent should possess in order to direct the subsequent operations of the methodology. For this application, the researcher assumes the role of linkage agent and responds to the list of criteria based upon his experience and current responsibilities as an industrial arts teacher-educator and as a doctoral-level researcher. Section I is outlined below on the left-hand side of the chart to provide an overview of its general intent and level of specificity. On the right-hand side of the chart are listed the corresponding skills and/or experience of this researcher.

Table 3

Satisfaction of the Criteria for Step I of the W-W Methodology

I. ATTRIBUTES OF PERSON APT TO USE THE LINKAGE METHODOLOGY EFFECTIVELY	Demonstrated Competency and/or Experience
A. Prior experience of person. 1. Person has successfully linked some aspect of knowledge production with some aspect of knowledge utilization within an institutional setting at least once, preferably twice.	o Teaching experience (nine years in industrial arts and vocational special needs).

2. Person's professional background and demographic characteristics and the professional background and demographic characteristics of the typical member of a targeted audience are reasonably compatible.	o Teaching experience as a classroom industrial arts teacher (one year). o Teacher-trainer in industrial arts (six years).
B. Person is able to devote considerable time (hopefully, at least one day per week to the linkage task.	o Time resources for work on the dissertation.
C. Person be counted upon to deliver promised services on time.	o Job requirement in teaching.
D. Person either has been trained to do some aspects of the following work of is accustomed to contracting with specialists for work desired.	
1. Assess needs of targeted audiences.	o MOE Research Report (UNH). o Needs Analysis Methodology course and research (UMASS-Amherst).
2. Survey literature for various reasons, be able to retrieve pertinent material, and be able to meaningfully summarize results.	o Comprehensive Paper (UMASS-Amherst). o Review of Literature, Dissertation Proposal (UMASS-Amherst).
3. Ascertain demographic characteristics and attitudes of targeted audiences.	o MOE Research Report (UNH).
4. Conceptualize and then expedite diffusion/utilization strategies and tactics.	o Teaching experience.

5. Conceptualize and then expedite evaluation strategies and tactics.	o Teaching experience.
6. Prepare coherent project reports.	o MOE Research Report (UNH).
E. Person understands basic elements of individual and group motivation and is able to apply such know-how routinely.	o Teaching experience.
F. Person listens well and communicates effectively. (Wolf 1983c, p. 1)	o Teaching experience.

Based on the above comparison, it appears that the requirements of the first section of the WWLM have been addressed. This researcher qualifies as a potential linkage agent.

Step II: The Satisfaction of Criteria A. - B. 1. The next section of the WWLM outlines the major objectives of this study. Again, the requisite steps of the methodology are compared to the resources and objectives of this study. The purpose of this comparison is two fold: 1) to respond item by item to the checklist of variables and procedures of the procedure; 2) to identify precisely how the research design and instrumentation relate to the WWLM, 3) to indicate the point at which this study's research terminates, and 4) to provide a perspective for the continuation of the larger effort to link energy, education with industrial arts in New Hampshire. The comparison appears as follows:

Table 4

Satisfaction of the Criteria for Step II of the Wolf-Welsh Methodology

II. IDENTIFICATION OF A TARGETED AUDIENCE'S NEED TO MODIFY SOME ASPECT OR ASPECTS OF PROFESSIONAL PRACTICE	Research Design, Methodology, Instrumentation
A. Define parameters of a targeted audience. 1. Specify members of a targeted audience (i.e., all persons in two elementary schools, or, special education personnel in a large city).	o Needers specified as population of classroom Industrial Arts teachers (grades 7 through 12) in New Hampshire.
2. Clarify roles of persons within the targeted audience (i.e., students, teachers, supervisors, administrators, etc.)	o Classroom teachers.
B. Ascertain needs of the targeted audience to modify practice, using modus operandi like the following: 1. Examine relevant materials (for example, local, state, and federal education policy shifts, expansion, or contraction.	o Validity of new knowledge documented by review of literature presented in this study. o Addressed by this study's Statement of the Problem.
2. Conduct surveys of various members of the targeted audience (use of packaged needs analysis methodology if applicable and if time permits).	o Coffing-Hutchinson Needs Analysis Methodology used by this study.
3. Compare practices of targeted audience with practices of other similar groups.	o Addressed by this study's review of Literature, Chapter II.
4. Examine available test results.	

5. Examine available demographic data (i.e., population trends) which pertain to the targeted audience.	o Researcher-designed instrument.
C. List and prioritize needs of targeted audience. 1. Prepare a list of the identified needs.	o Needs Analysis Methodology.
2. Distribute the list to various members of the targeted audience for the purpose of determining their priorities (repeat as necessary until until a clear picture of priorities unfolds.)	o Needs Analysis Methodology.
3. Use members' responses as a point of departure for estab- a prioritized list of needs.	o Research Design, Chapter III, of this study.
D. Clarify who will participate in the final selection of the specific need or needs to be addressed (i.e., a committee, all inolved persons, etc.).	o Study terminates at this item. o Suggestions/Recommendations to be offered.
E. Use the following criteria to facilitate selection of the specific need or needs to be addressed. 1. Resources required to meet the need or needs.	
2. Time required to meet the need or needs.	
3. Positive and negative consequences of meeting the need or needs.	
4. Extent of target audience support/ agreement. (Wolf 1983c, pp. 2-3)	

It should be evident from the two comparisons outlined above that this study attempts to follow precisely the WWLM in addressing the energy education knowledge gap involving the state of New Hampshire's industrial arts teachers and regional energy experts. By the linkage methodology's criteria, three conditions have been established. First, this researcher qualifies as a "linkage agent". Secondly, this study's statement of the problem and review of literature document the knowledge gap between national and state-level energy education and industrial arts education. And thirdly, the research design and instrumentation of this study should be targeted for the identification and priority listing of the energy education needs of the industrial arts teachers from New Hampshire. The next section of this review of literature defends the selection of the Coffing-Hutchinson Needs Analysis Methodology as the major component of the research design.

Needs Analysis Methodology

Needs Assessment in Education. Brush (1974, 1976) reviewed the current literature on the topic of needs assessments, specifically in education, and concluded that a surge in the member of these types of studies during the late 1960's and the decade of the 1970's was the product of four sources of pressure:

> The general community has demanded much more accountability from educators as to where its tax dollars go, and educators have therefore wanted to present to the public hard data about necessary educational programs; the Federal Government demands needs assessments as prerequisites to gaining federal funds under the Elementary and Secondary Education Act of

> 1965...; the tremendous increase since World War II in the number and complexity of vocations has required a parallel growth of school curricula and thus of the necessity for assessment to determine needs for the various areas; and, finally, the thrusts toward individualization require knowledge of what the student perceives as necessary, not just the knowledge of the educational administrator. (Brush 1974, p. 2)

All of the above reasons relate to this study, but accountability, limited funding, vocational and technical complexity and growth, and the demand for hard data for decision-making are key reasons, and, therefore, major challenges for this study.

Furthermore, Brush (1976) reviewed the many definitions of educational needs assessments and distinguished three general categories of definitions, each stressing different functions. Needs assessments are viewed variously as:

1) early identification steps in systematic processes designed to move from goal-setting to the implementation of specific programs.
2) a process of providing data for decision-making.
3) a tool that is used primarily to ascertain the discrepancy between "what is" and "what ought to be."

What was significant about these definitions was not the different emphases, but their combined expectations of needs assessments' roles.

> All of the definitions are important. Jointly, they signify a conscious plan with definite steps, as part of a larger process in educational planning to construct eductional programs which will focus on what needs to be done to satisfy federal and state requirements community and school-district goals, and teacher and learner objectives. (Brush 1974, p. 3)

Brush continued his study by describing needs assessment projects from the period 1945 to 1975. In attempting to find common denominators among the projects' multiplicity of variations, Brush determined that these projects depended largely upon: 1) live interviews, 2) questionnaire surveys, or 3) confrontation of live interviews and questionnaire surveys. The striking fact about the projects Brush described was that researchers and project leaders tackled such a wide variety of target groups; in one case, six groups were asked to be informants. Another interesting phenomenon was the wide variety of project goals; needs, questions, solutions, opinions, perceptions, comparisons, lists, performance levels, goals, choices, and preferred school calendars were all likely data items. Despite this wide range of data concerns and the wide variety of instrumentation, Brush reported that only two researchers addressed the greater question of needs assessment design and only one researcher cited limitations to his methodology.

The Coffing-Hutchinson Needs Analysis Methodology. It is within the context of this void of needs assessment design that T. Hutchinson of the University of Massachusetts at Amherst and R. Coffing of the Ohio State University developed a rigorous needs assessment model, labeled "Needs Analysis Methodology" (hereafter designated NAM). Brush rated this model as the most useful methodology discovered in his review of literature; it was by far the most specific and complex. Additionally, as a systems design, the NAM is diagrammable in terms of clearly defined procedures and sequences. Brush pointed out several factors that make the NAM so powerful in relation to previous models.

> Where NAM differs from other models is (a) in its broad applicability to many kinds of needs assessments, (b) thus, in its complexity of process so as to be responsive to a broad band of options, (c) in its being based on well defined and stipulated assumptions, (d) in its explicit formulation of directions for each step, and (e) in its demand to operationalize definitions of needs as specifically as possible and thus in as potentially usable a form as possible by information users. (Brush 1976, p. 45)

The study by Brush showed that needs assessments are educational research's response to the recognition that 1) people's needs should be listed as a primary criteria for designing, implementing, and evaluating educational programming and that 2) hard data for decision-making is demanded by the development of more systematic, decision-making strategies being adopted by educational agencies. Coffing and Hutchinson (1974) in their study, "Need Analysis Methodology: A Prescriptive Set of Rules and Procedures for Identifying, Defining, and Measuring Needs" constructed for the field of needs assessment a definitive cenceptualization of this research tool, a set of assumption bases, a systems approach to model building, the synthesis of a sequential list of procedure and rules, and a set of limitations. The result of this conceptualization process was a methodology defined as a systematic, operational, and standard set of rules and procedures designed to accomplish a defined purpose--to provide needs data for decision-making.

The unifying theme of the NAM is this basic needs analysis question: "Who needs what, as defined by whom?" Given this framework for inquiry into people's needs, some elements of NAM are defined as follows (Coffing and Hutchinson 1974):

1) needs what--"a 'need' is a concept of some desired set of conditions; a 'need' is a concept of 'what should be.'" (p. 5)
2) who needs--the individuals or groups to whom the need is attributable; these target groups are called "needers."
3) by whom--the individuals or groups who conceive the need, are called "definers."

The process through which this basic question is explored involves five sub-purposes:

1) To manage the process.
2) To specify the basic scope and priorities.
3) To identify the information users' concerns.
4) To obtain and report definitions of needs.
5) To obtain and report measurements of need fulfillment. (Coffing and Hutchinson 1974, p. 14)

Furthermore, these five sub-purposes are implemented by a sequence of ten sub-sets of procedure which in turn correspond directly with the design of this study (Coffing and Hutchinson 1974):

Needs Analysis, and 10.0 Revising. The person who manages the process is called the "needs analyst". This researcher assumed the role of the needs analyst for the purposes of this study. In preparation for this role, the researcher enrolled in an appropriate graduate seminar, "Need Analysis Methodology" (lead by T.E. Hutchinson), as a course in his doctoral program. One product of this seminar was a brief, forty-hour needs analysis research project. The planning, component of the management component involves two processes: 1) the development of the dissertation proposal and 2) the implementation of the dissertation study itself. In the study's section addressing conclusions and recommendations, there are evaluations of the study's attempt to implement the NAM as applied to identification and definition of industrial arts teachers' needs for energy education knowledge. Lastly, it should be noted that revisions may take place during the implementation of the research instruments, during the definition reporting phase, or during both processes.

Two groups of questions are asked under the heading of "Specifying the Basic Scope and Priorities": 1) who are the "decision-makers or "information users" who require the data for decision-making and 2) what resources are available to the needs analyst. These considerations are formulated by contract, formal or informal, between the needs analyst and the "contract decision-makers." In other words, the needs analysis is a commissioned service. The person(s) controlling the resources contracts for the service based upon two criteria--what resources are available for the project and who are decision-makers or information users. For the purposes of this study, the researcher was both the needs analyst and contract decision-maker. However, the dissertation committee served as an advisory committee to the researcher acting in this dual role. The development of the dissertation proposal paralleled the process of contract negotiation, and the acceptance of the proposal can be viewed as the signing of a contract. The "linkage agent" in the WWLM is designated as the decision-maker, and the organization of the NAM at the "Definition Reporting" sub-set reflects a decision based largely upon resource allocation parameters.

Step II: The Satisfaction of Criteria B.2 - C.3. The third sub-purpose "Identifying Information Users Concerns" and the corresponding procedure of determining the who-what-whom concerns was addressed through preliminary work by this researcher culminating in a comprehensive examination paper, "Energy-Education and Industrial Arts Education: Developing A Perspective for Policy Decision-Making." Further exploration of the basic needs analysis question occurred during the proposal stage of this study. During this proposal stage, a variety of "who needs what, as defined by whom" phrases were formed and prioritized. Two phrases of concern were selected, and this selection process is described by this study's review of related literature, the statement of the problem and the research design. The who-what-whom statements are:

1) Industrial arts teachers' need for knowledge to teach renewable energy education as defined by the teachers themselves.

2) Industrial arts teachers' need for knowledge to teach renewable energy education as defined by renewable energy experts.

Further refinement of these phrases precisely defined the two target groups (teachers and experts) and the definition of energy education knowledge.

The research design and instrumentation of this study follow step-by-step the NAM and, in doing so, fulfill the fourth sub-purpose and sub-sets 5.0 Defining and 6.0 Definition Reporting as outlined in Figure 3. These operations are described in detail under the study's Chapter III labeled Research Design, Methodology, and Procedures. These operations, therefore, concurrently satisfy the criteria of the WWLM, Step II B.2.-C.3.

Lastly, the sub-purpose of "Obtaining and Reporting Measurements of Need Fulfillment" and the corresponding steps "7.0 Measuring" and "8.0 Measurement Reporting" must be explained further. Traditionally, needs assessments have attempted to determine the "discrepancy," the observed difference between "what should be," or the need, and "what is," the degree of need fulfillment. Coffing and Hutchinson (1974) graphically defined the relationship among the concepts of "need," "need fulfillment" and "discrepancy" with the following diagram.

The definition of need as provided by sub-sets 5.0 and 6.0, defining and reporting, simply provides the criteria for observing need fulfillment. The measurement of discrepancies, although an important type of data for decision-making, requires considerable resources,

resources far beyond those commensurate with this type of study. However, the specific definition of the needer's needs often makes the current status or discrepancy obvious to the information users. Some examples of this type of measurement that relies upon the information user's organization of knowledge and data in response to defined need are enumerated in this study's chapter on the presentation and analysis of the data.

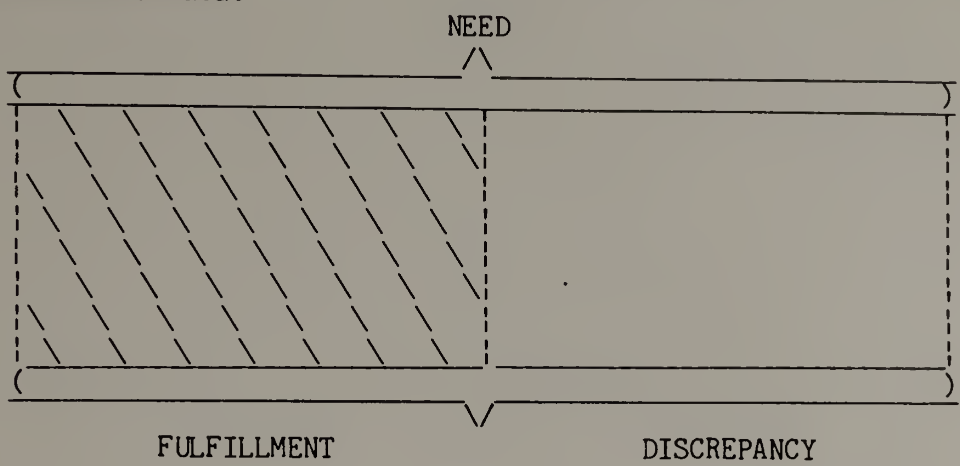

Figure 4. Relationship Among the Concepts of "Need", "Need Fulfillment", and "Discrepancy", as Used in Needs Analysis Methodology (p. 6)

Identifying Teacher-Trainer Candidates

The last major objective of this study is to identify a group of New Hampshire industrial arts teachers who should be further screened as energy education teacher-trainer candidates. This process by-passes three major steps in the WWLM's nine steps process, but it is offered not without reason. The three steps to be by-passed (III, IV, V) concern respectively the identification, selection, and modification of practices and/or products selected to meet identified needs of targeted audiences. These operations can only be carried out after the identification, prioritization and selection of the needs to be addressed. However, screening for potential teacher-trainers was initiated as a component of this study's research design and was administered along with the demographic and needs analysis sections of the research instrument. The comparison of the WWLM Step VI with this study's design provides a perspective of this last objective.

VI. DETERMINATION OF DEMOGRAPHIC CHARACTERISTICS AND CERTAIN ATTITUDES (TOWARD THE PLAN TO MODIFY SOME ASPECT OR ASPECTS OF PROFESSIONAL PRACTICE) OF THE TARGETED AUDIENCE

A. Survey members of the targeted audience to ascertain their prior history of professional self-renewal.

1. Identify those persons (self-renewers) who routinely modify their professional practice.

---

2. Identify those persons (entrenchers) who seldom modify their professional practice.

B. Use an uncomplicated sociometric survey technique (many options are available) to ascertain who are the "influentials" and who are the "isolates" within the targeted audience.

1. Identify the influentials.

---

2. Identify the isolates.

C. Interview a sample of the identified self-renewers and the influentials to determine their respective attitudes toward the practices and/or products selected to meet specified needs of the targeted audience.

1. Affirmation is a positive indicator.

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2. Either mixed reactions or opposition indicates further action must be contemplated.
   a. Review specifics of the interviews completed to isolate the sources of controversy.

b. Eliminate controversial aspects of the implementation undertaking if possible.
c. If controversial aspects cannot be eliminated, confront the sources of controversy and either overcome them or neutralize them.
d. Discontinue the attempt to modify professional practice, using the selected practices and/or products, if the controversy persists in force.
e. If the problem continues to fester, go back to Step II and try again.

D. There is no need to invest either time or resources interacting with persons identified as entrenchers or isolates at this point in the implementation process. (Wolf 1983c, pp. 7,8).

The importance of identifying potential teacher-trainers is revealed in the next section of the WWLM Step VII "Conceptualization and Implementation of Strategies and Tactics." This section describes the actual transfer of new knowledge to the target population. In educational language, the key group of identified "self-renewers" and "influentials" would be labeled teacher-trainers, and these people do the teaching in the new content area. The underlining of certain phrases is an editorial device to emphasize the role of this group.

VII. CONCEPTUALIZATION AND IMPLEMENTATION OF STRATEGIES AND TACTICS INTENDED TO INCORPORATE DESIGNATED PRACTICES AND/OR PRODUCTS WITHIN THE PROFESSIONAL PRACTICE OF THE TARGETED AUDIENCE

A. Conceptualize a strategy (with appropriate tactics) which meets five conditions.

1. The strategy is geared primarily to the enterprise of persons identified as self-renewers and influentials, but it also involves all persons who will be influenced by modifications in practice.

2. The strategy involves two steps: Step one focuses upon self-renewers and influentials; step two utilizes these persons to influence others in the targeted audience.

3. The strategy makes maximum use of interpersonal (preferably face-to-face and two-way) channels of communication.

4. The strategy is participative in that all persons who are to be affected by the modifications in practice participate in making decisions about the undertaking.

5. The strategy incorporates a time line which projects the realization of specified aspirations.

B. Offer the conceptualized strategy (with appropriate tactics) to selected persons identified as self-renewers and influentials for their critical review, and then modify it on the basis of feedback provided.

C. Implement the strategy (with appropriate tactics).

1. Expedite step one of the two-step plan.
   a. Utilize varied interpersonal channels of communication to introduce the selected practices and/or products to be previously identified self-renewers and influentials.
   b. Work closely with the self-renewers and influentials until a core of them have modified their professional practice as desired.
   c. Recruit from the core of successful persons a small number willing to become involved in generalizing the modifications in practice to other persons within the targeted audience.

2. Expedite step two of the two-step plan.
   a. Utilize varied interpersonal channels of communication to share desired modifications in the practice of the recruited self-renewers and influentials with other Members of the targeted audience.
   b. Work closely with the recruited self-renewers and influentials during their attempts to convince selected peers to modify practice as desired.
   c. Continue the process of interaction until a substantial core of the targeted audience has modified professional practice as desired. (Wolf 1983c, pp. 9,10).

Given the critical role of the "influentials", the identification of this group of industrial arts teachers from New Hampshire could be a major contribution. This identification process was carried out by a simple survey procedure. In the mailings of the NAM instruments, a sociometric survey asked the industrial arts teachers to list the names of five colleagues whom they would choose to provide in-service training in renewable energy education, including energy conservation. An analysis of these initial responses identified those industrial arts teachers respected by their peers for both their subject knowledge and leadership skills. This process eliminates those teachers who may possess energy education expertise, but who do not command the respect of their colleagues. However, the identification of "self-renewers", the target audience for the "influentials" is yet another step away in the WWLM, and that process was not pursued in this study.

Summary

The organization of the preceding review of literature, in particular, and this study, in general, can be compared to the construction of a pyramid. The foundation was built as a large, powerful base. That foundation was the argument and its supporting documentation that energy production and consumption are critical issues for this nation. Factors aggravating the energy problem were identified as the lack of national energy policy and the misinformation generated by numerous, conflicting energy education agencies. Once this base of problem identification was solidified from a large body of data, the study progressively narrowed its parameters of concern, starting with public education's response to energy issues and concluding with the inter section of energy education and industrial arts. The final focus of the review was the examination of reasons for enlarging this intersection, for encouraging linkage between an advancing technology and a traditionally-oriented educational field based upon the redefinition of energy education and the potential impact of this knowledge base on industrial arts programming. Lastly, it was proposed that, for the purposes of this study, the WWLM was an appropriate systems-approach strategy for linking knowledge producers (renewable energy experts) with knowledge users (industrial arts teachers).

The balance of the review of literature involved matching the objectives of this study with the WWLM blueprint in order to identify those criteria that had been satisfied by the previous work of the researcher, by the review of related literature, itself, and by the application of the Coffing-Hutchinson NAM. It is the application of this particular NAM that constitutes in large part the research design, methodology, and procedures of this study.

CHAPTER III

RESEARCH DESIGN, METHODOLOGY, AND PROCEDURES: Implementing the Linkage Methodology

Overview of the Chapter: Research Design

During the past four years, pressures from the grassroots level to the state-policy level have communicated the need for renewable energy technology to be incorporated into the State of New Hampshire's industrial arts programs. In order to bridge the gap between knowledge producers (renewable energy experts) and knowledge users (industrial arts teachers), an appropriate data base for policy decision-making at the state level is required. This study's objectives were designed to provide that data base.

Chapter II addressed two of the four major objectives of the study. First, Chapter II provided an overview of national energy issues, governmental intervention, and energy education in order to determine the appropriateness of energy conservation and renewable energy technology as a subject content in industrial arts education. Secondly, Chapter II introduced the Wolf-Welsh Linkage Methodology (WWLM) as a knowledge production/knowledge utilization model compatible with the mandate to infuse renewable energy technology into the State of New Hampshire's industrial arts programs (Wolf 1984). Based upon the role of the WWLM as a blueprint for change, the researcher selected the Needs Analysis Methodology (NAM) (Coffing and Hutchinson 1974) as the standardized, operationalized set of procedures for providing a list of identified, prioritized needs of renewable energy knowledge as perceived by two groups--New Hampshire's industrial arts teachers and renewable energy experts. The following chapter will introduce the implementation of a research design developed by the researcher to fulfill major requirements of the WWLM model and to administer the procedures outlined in the NAM.

The research design for this study can be outlined as four components: 1) sampling, 2) NAM, 3) demographic data, and 4) statistical procedures. First, this Chapter will describe the procedures used to identify both populations. The selection of subjects, or sampling, was based upon the development of two needs statements, both of which referred to the State's industrial arts teachers' need for knowledge in order to teach renewable energy education. For one statement, the need for this knowledge is perceived by the knowledge producers, the renewable energy experts. The identification of the teachers was relatively straightforward; however, the identification of the renewable energy experts was time-consuming and required a peer-nomination process.

Secondly, this Chapter will record the series of four steps of the NAM which were used to define: a) industrial arts teachers' need for knowledge in order to teach renewable energy education as defined by industrial arts teachers, and b) industrial arts teachers' need for knowledge in order to teach renewable energy education as defined by renewable energy experts. The implementation of the NAM met the third objective of the study to provide two lists of identified and prioritized needs as described in the above two needs statements. The two products of the NAM, the two lists of prioritized needs, inherently represented valuable data for policy decision-making. However the two lists also represented an opportunity to compare the perceptions of the teachers and the experts. This comparison was investigated by testing the following null hypothesis: H_1 There will be no relationship between the perceived needs of industrial arts teachers and the perceived needs of renewable energy experts pertaining to the teachers' need for knowledge to teach renewable energy education. Such a comparison helped to describe the degree to which the primary knowledge users (teachers) and knowledge producers (experts) agreed/disagreed--a valuable comparison based upon the NAM results.

This Chapter will also describe the development of the third research design component, the demographic questionnaire that included demographic data concerning the industrial arts teachers and a brief, sociometric survey that asked the teachers to nominate colleagues as in-service instructors. This demographic data, along with the NAM results and additional data analysis, was used to meet the fourth objective of the study, the identification of potential teacher-trainers.

The fourth component of the research design involved analysis of the NAM results and demographic data. This Chapter will describe the data analysis that assisted in meeting the last two objectives of the study--the investigation of two lists of needs statements and the identification of influential teachers. Specifically, a rank order correlation was used to test hypothesis H_1 (stated above) that refers to the degree of agreement/disagreement between the industrial arts teachers and renewable energy experts concerning the teachers' need for knowledge to teach renewable energy education.

Further statistical analysis used to identify influential teachers was based on data from several sources, including the two lists of identified prioritized needs, and the demographic data and the nomination survey results from the demographic data. These statistical procedures will be outlined in detail in the last section of this Chapter, particularly in relation to the second and third hypotheses of this study.

Subjects

Industrial Arts Teachers

Two populations were targeted by this study--industrial arts teachers and renewable energy experts. The population of industrial arts teachers consisted of New Hampshire's approximately 325 teachers instructing in grades 5 through 12. This number represented the entire population of industrial arts teachers in the State of New Hampshire identified by the Industrial Education Teacher Directory published by the New Hampshire State Board of Education for 1983-1984.

Renewable Energy Experts

The second population consisted of New Hampshire-oriented renewable energy experts who were identified by the following three-step process. First, a list of criteria was developed with the assistance of several energy professionals to screen individuals for renewable energy expert status. The criteria for identification as a renewable energy expert were: 1) to work in the area of energy conservation and renewable energy technology, 2) to be oriented to practices appropriate to the State of New Hampshire, 3) to have exhibited technical expertise in their area, and 4) to have the ability to communicate their knowledge as shown by presentations and/or publications, work with professional trade associations, or educational efforts.

Secondly, two lists of prospective renewable energy experts were provided by the two appropriate organizations--the New England Solar Energy Association (NESEA) and the New Hampshire Solar Energy Association (NHSEA). These organizations provided extensive membership and mailing lists--for newsletters, journals, workshop and conference advertising, trade association activities, etc. These mailing lists proved to be particularly appropriate for this study. The individuals identified by the NHSEA/NESEA Directors from their organizations' mailing/ membership lists represented comprehensive coverage of the wide range of technical areas and personnel roles associated with energy conservation and renewable energy technologies throughout New England. Using the criteria previously selected, Alex Wilson of NESEA selected fifty individuals, and Jeff Clark of NHSEA selected an additional sixty-two individuals, eleven of whom were identified on the NESEA list. The first round, therefore, provided the names of 101 prospective renewable energy experts.

The third and final step of the expert identification process involved surveying those 101 individuals to determine whom they would identify as experts. The survey was field-tested with assistance from the NESEA leadership. After two revisions based upon the field-test results, a cover letter and answer sheet were constructed and mailed to the 101 individuals. The cover letter/answer sheet instrument retained the original list of four criteria for screening prospective energy experts (see Appendix A). Concurrent with the mailing of this survey, telephone calls were made to prepare these individuals for the survey, to "break the ice" as it were. Sixty-two individuals responded to this first-round of contact. A second round of follow-up surveys and telephone calls was therefore conducted.

Of the 101 individuals contacted, ninety-two finally responded in writing or directly over the telephone. These ninety-two responses generated a master list of 344 nominees for renewable energy expert status. Lastly, the responses were tabulated to record how many times and by whom each individaul was nominated. Ninety-six individuals were identified more than four times by their colleagues (see Appendix A). These ninety-six individuals therefore represented the population of renewable energy experts for the purposes of this study.

Needs Analysis Methodology

Identification of Needs

As previewed in the overview of this chapter, two needs phases in the form of "who needs what as defined by whom" were developed to produce data for decision-making:

1) Industrial arts teachers' needs for knowledge in order to

teach renewable energy education as defined by the teachers themselves.

2) Industrial arts teachers' needs for knowledge in order to teach renewable energy education as defined by renewable energy experts.

In the NAM scheme, the Major Process V: Defining required that the definers provide their definition of a specific kind of need--for this study, industrial arts teachers' needs for knowledge in order to teach renewable energy education. Furthermore, the "definers" were the two distinct groups of industrial arts teachers and renewable energy experts; they were the "whom" in the needs phase "who needs what as defined by whom." As described in the above section "Subjects," the teachers are identified specifically as New Hampshire's approximately 325 industrial arts teachers, and the renewable energy experts were the ninety-six individuals nominated and identified by their colleagues.

The process of identifying needs depends upon obtaining the definers' definitions of needs. These needs statements had to explicitly describe what the definers imagined would be present or what would be happening if the needs of industrial arts teachers for knowledge in order to teach renewable energy education were completely met. Because two distinct groups of definers were to be polled, two defining "stimulus questions" were developed following the steps prescribed by the NAM Section V., Defining. Both stimulus questions were field-tested and revised prior to use.

Three versions of a stimulus question (see Appendix B) were submitted to the NESEA leadership, and after editorial changes, the stimulus question to be directed at renewable energy experts was finalized as follows (see Appendix B for cover letter and survey instrument):

Stimulus Question

> Imagine that all of New Hampshire's industrial arts teachers are providing instruction in renewable energy education. Furthermore, their efforts are contributing to a comprehensive, kinderarten through twelfth grade program in energy conservation and renewable energy education that is operating successfully in the state's public schools.
>
> Given this scenario, imagine further that the state's more than 300 industrial arts teachers are successfully presenting concepts and developing lab activities that are helping students in both junior and senior high programs to learn about energy use, conservation, and renewable energy sources.
>
> As you think about these successful efforts, what information did the industrial arts teachers acquire that met their needs for knowledge to teach energy conservation and renewable energy education. Please make a list of that information.

The stimulus question for industrial arts teachers was developed with assistance from the Industrial Arts Consultant, New Hampshire State Department of Education. It was field-tested at the Spring (1984) business meeting of the New Hampshire Industrial Education Association (NHIEA) and was accepted as it appears below (see Appendix B for the teacher definer survey instrument and cover letter):

> Imagine that all of New Hampshire's industrial arts teachers are providing instruction in renewable energy education. Furthermore, their efforts are contributing to a comprehensive, kindergarten through twelfth grade program in energy conservation and renewable energy education that is operating successfully in the state's public schools.

Let's also assume that the state's definition of energy education is built on three assumptions. The first assumption is that energy conservation is more accurately defined as a renewable energy source. The second assumption is that the political, economic, social and environmental impacts generated by a decentralized system of renewable energy sources and their conversion technologies are also positive and beneficial. And lastly, the following outline of renewable energy sources and technologies is an appropriate scheme for organizational purposes:

I. Energy conservation
II. Thermal (heating and cooling applications)
   o heating and cooling of buildings
   o heating of water
   o agricultural and industrial process heating
III. Fuels from biomass
   o plant matter, including wood and waste
IV. Solar Electric
   o solar thermal electric
   o photo-voltaics
   o windmills
   o ocean thermal electric
   o hydropower

Given this scenario, imagine further that the state's more than 300 industrial arts teachers are successfully presenting concepts and developing lab activities that are helping students in both junior and senior high programs to learn about energy use, conservation, and renewable energy sources.

As you think about these successful efforts, what information did the industrial arts teachers acquire that met their needs for knowledge to teach energy conservation and renewable energy education. Please make a list on the enclosed sheet of what these teachers learned.

The selection process for the sample of the definers who are to be asked to respond to the stimulus question was outlined in specific terms by the NAM covering three cases: 1) where the definer is an individual (Case I), 2) where the definers are a group of persons that number less than 11 (Case II), or 3) where the definers are a group of persons that number more than 10 or less than 101 (Case III). In this study, the two groups of definers, teachers and experts, exceeded the upper limit. The NAM indicated that in this situation (Case IV) the steps for Case III should be followed, making appropriate adjustments where necessary (Coffing et al. 1973, p. A-32). Other researchers utilizing the NAM have encountered the Case IV situation. Magid (1981) describes the problem and its resolution:

> The methodology does not specify that the definers should be randomly selected, only that they have the necessary knowledge or perspective from which to develop need statements that will be reflective of the population as a whole. Although the methodology does not specify an optimal number of definers, it does suggest that the number be kept large enough to provide a thorough list of potential needs, but small enough to be manageable. (p. 47)

The researcher consulted with NAM co-author Thomas Hutchinson, and it was determined that a sample of twelve to fifteen definers from each population of teachers and experts would be an optimum number. Furthermore, the definers were to be selected as a sample group that would have the perspective and expertise to represent effectively the various strata of the two populations and to generate the need statements representative of both populations.

The process for selecting the representative samples for the teacher and expert populations required the construction of demographic profiles for both groups. Richard Doble (1977) studied the correlation between change-oriented characteristics and demographics of New Hampshire's industrial arts teachers. His study's instrumentation included a demographic survey, and his research indicated that the State's industrial arts teachers could not be defined as single craft-area instructors. The researcher used other appropriate studies (Beauvais 1981, Kleinbach 1981, and Winek 1981) to determine potential demographic factors. Using the demographic factors outlined in these studies, the researcher constructed a list of demographic factors that would assist in the selection of a representative teacher sample. Examples of these factors were large/small schools, rural/urban schools, single craft/multiple craft teaching responsibilities, single/dual teaching certificates, etc. The selection of fifteen teachers who were representative of the total industrial arts teacher population was made with the assistance of the State's Industrial Arts Consultant. The NHIEA leadership also assisted by providing names of individuals who had expertise in energy education. The final list of teacher definers and demographic factors is recorded in Appendix C. It was not anticipated that difficulties would be encountered in polling the fifteen teacher definers, and, indeed, all fifteen did respond to the definition survey.

The selection of a representative sample of renewable energy experts was straightforward, but a potential problem of logistics was anticipated. First of all, a list of energy conservation and renewable energy technologies had been generated by the researcher from the review of literature. The researcher used this list to insure the selection of a sample of renewable energy experts who, as a group, had expertise in a wide range of energy conservation and renewable energy technologies. Secondly, the Directors of the New England Solar Energy Society (NESEA) and the New Hampshire Solar

Energy Society (NHSEA) had indicated the area of expertise, type of organization, and personnel role of the 101 individuals they had identified as potential renewable energy expert candidates. The NESEA Director later assisted in the selection of sixteen individuals (from the identified expert population of 101) as expert definers who represented the various perspectives and areas of expertise of the renewable energy expert population (see Appendix D).

The NESEA Director and researcher also selected several individuals to serve as back-ups for each of the original sixteen expert definers (see Appendix D). The decision to create a pool of forty-two expert definers was done purely for logistical reasons. The expert definers included nationally-recognized leaders, researchers, and entrepreneurs--individuals who often are well-insulated by secretarial and office staffs from direct contact. Their workloads often preclude attention to every request from the large number of surveys, inquiries, etc. their positions often attract. Lastly, these individuals are often out of town for extended periods of time. Therefore, to insure coverage of the diverse and well-defined strata of the expert group, three individuals were selected as potential respondents for each of the sixteen expert definers selected.

This modification of the selection process was dictated by the researcher's experience in gathering responses from the experts during the expert identification process. However, the modification proved to be an unnecessary, but justifiable precaution.

Following the field-testing of the stimulus questions and the selection of representative definers for the teacher and expert groups, the survey instruments along with an explanatory cover letter (Appendix B) were either hand-delivered or mailed to the definers. In the case of the teacher definers, the researcher had the opportunity to hand-deliver the instrument to six of the fifteen individuals at the New Hampshire Industrial Arts Festival (April, 1984). This delivery system enabled the researcher to introduce the survey form, to allow the definer time alone to read it during the conference, and later to answer questions about the instrument and/or the research project itself. Concurrent with the mailing of the balance of the instruments, the researcher called the nine remaining teacher definers to alert them to the survey and the importance of their response. The definers were asked to respond within one week. All fifteen of the fifteen teachers polled responded within the time limit for a 100% return rate (Appendix C).

To encourage the renewable energy experts to respond, this researcher reinforced the experts' motivation with three points of information: first, this researcher called all the experts the day after the mailing to alert them to the fact that a survey would be in their mail that very day or the next day at the latest; secondly, the explanation of the survey was outlined; lastly, the researcher offered to send respondents Vermont maple syrup (from the researcher's farm) if they made the deadline the following week. All sixteen expert definers responded within the time limit for a 100% return rate. Of the remaining twenty-six experts selected to back-up the original expert definers in the event of non-responses, twenty-four of these individuals responded within the time frame. The response rate for all forty-two definers was 95% (see Appendix D). However, for the purposes of this study, only the responses of the original sixteen expert definers were used to produce the final list of needs statements. The response rate for the sixteen expert definers was, therefore, 100% (see Appendix D).

In addition to the satisfactory return rates for this defining survey, each individual definer in the teacher and expert sample produced a considerable list of needs statements. The stimulus questions, as open-ended questions, were designed to set the parameters for the definers' responses while, at the same time, encouraging a free flow of information from the definers. This free flow of information of teachers' needs was evident from the definers' multitude of items and their eclectic response format that included not only lists, run-on phrases, stream-of-consciousness narratives, but also excerpts from table of contents, workshop advertisements, pamphlets, lists of resource materials, and highly-structured essays. A sample return for each definer group can be found in Appendices C and D.

The task of sorting through the definers' responses required careful record-keeping. The researcher first constructed a theoretical framework for organizing need statements based upon the review of literature and an initial review of the definers' responses

(Appendix E). Next, the researcher addressed each definer's response, isolated discrete need statements, and wrote a single need statement on a 3 x 5 index card. Approximately 1100 discrete need statements were identified. After grouping together need statements of similar content and separating out those that represented a unique need, the cards were organized according to the theoretical framework. The theoretical framework was at that point modified. Although this framework was intended for the researcher's use, the main headings were retained as the category headings for the final survey (see Appendix E).

The document that represented the expert and teacher definers' identification of needs contained 493 discrete need statements. Each need statement was placed in the list under the appropriate category. Lastly, each need statement was listed along with the identification number(s) of the definer or group of definers that nominated that particular need.

Prioritization of Needs

In this phase of the study, the two populations of industrial arts teachers and renewable energy experts prioritized the elements of the needs definitions produced in the prior phase. It was these two prioritized lists of perceived needs that formed the raw data for comparisons of the opinions of the teachers and the experts.

The final list of need definitions, representing the combined responses of both samples of the teacher and expert definers, contained 493 discrete need statements. The length of this instrument posed a potential problem for respondents. The projected time needed to answer a 493-item survey was estimated at one to two hours. Possibly more troublesome was the likelihood that respondents would "burn out" and would, therefore, produce invalid responses. The researcher consulted with NAM co-author Dr. Thomas Hutchinson, and it was determined that two surveys would be constructed from the original 493-item survey. These two surveys, in turn, would be mailed to random half samples of energy experts and industrial arts teachers.

The two forms of the Renewable Energy Survey were then field-tested. Six renewable energy experts or expert candidates and six industrial arts teachers were contacted at this time. Experts and expert candidates were selected based upon their interest in the task of bringing renewable energy education into the public schools. The industrial arts teachers selected taught in Vermont and represented the major strata of the profession (Appendix F). The field-test was conducted in two ways. For some of the experts/candidates and teachers, they were told that they were field-testing a survey instrument. For the balance of the expert/candidates and teachers, they were simply asked to fill out the survey. Both groups returned the survey, either with comments or with the appropriate responses. Both groups were then contacted either in person or by telephone and asked to comment on the survey.

Based upon the field-testers' written and verbal comments, several modifications were pursued in constructing the final two forms of the Renewable Energy Survey (see Appendix G). First, the survey's list of needs was judged to be comprehensive; it covered the full range of energy conservation and renewable energy technologies. Several minor grammatical and technical corrections were noted, however. Secondly, several field judges suggested that a theoretical framework or table of contents be displayed conspicuously at the beginning of the instrument to help orient readers. Such an outline was constructed and high-lighted, and main headings were also emphasized throughout the survey to help respondents keep track of the different topic areas.

Thirdly, one field judge issued the serious warning that a 250-item survey was simply too long, and that the return rate would suffer dramatically. The option of reducing the total number of needs statements presented numerous problems. The original 493-item list had already been divided into two parts. Further division of the survey items would have led to problems of sample size. The reduction of the original list through the evaluation efforts of a selected sample of experts and teachers was considered. A possible method for deleting needs statements was outlined: the original teacher and expert definers would be asked to prioritize the 493-item survey. Those items ranked low, for example in a lower quartile or at a self-evident cut-off point, would be deleted from the final survey form. This procedure or other similar attempts to reduce the list of needs statements would have required an additional time-consuming series of survey mailings, the selection of sample respondents, and the justification of criteria to delete need statements. In short, this solution offered more potential problems than it would have solved. The researcher decided to adhere to the two forms of the survey based upon other factors. All of the field-test respondents had completed the survey, including the person who had issued the warning. Also, the experts had shown in the earlier rounds of the identification process that they were highly motivated with regard to renewable energy education. Lastly, despite the length of the survey, the field-test respondents did not experience difficulty with the scoring/response format.

Demographic Data

Industrial Arts Teacher Demographic Data

The demographic questionnaire was designed to provide the data for the fourth and last major objective of the study, the identification of potential teacher-trainers. In order to accomplish this objective, the demographic data had to meet three criteria listed in the WWLM: 1) the clarification of roles within the targeted audience (Step II. Criteria A.1., A.2.); 2) examination of demographic data which pertains to the targeted audience (Step II. Criteria B.5.); and 3) the identification of those teachers (self-renewers) who routinely modify their professional practice and those teachers (entrenchers) who seldom modify their professional practice (Step VI. Criteria A.1., A.2.) (Wolf 1983c, pp. 2,3,7,8). The demographic questionnaire, "Teacher Data Sheet," provided demographic data for industrial arts teachers (professional development, teaching experience, age, subject area, etc.) and a brief, sociometric survey that asked teachers to nominate colleagues as in-service instructors. The data from this questionnaire was later analyzed to test two hypotheses and to assist in the identification of potential teacher-trainers.

The demographic questionnaire developed by the researcher was designed to obtain specific personal information about each industrial arts teacher. The selection of fifteen teacher definers introduced the researcher to Doble's work (1981) on a demographic questionnaire for a similar population and the efforts of Beauvais (1981), Kleinbach (1981), and Winek (1981) involving the demographics of industrial arts teachers across the country. Other dissertations involving NAM and demographic concerns were reviewed by the researcher and included work by Magid (1981), Maxner (1979), and Brush (1976). The review of these studies provided background information concerning a considerable list of demographic factors applicable to a number of different populations.

For the purposes of this study, the basic demographic factors were determined to be age, teaching experience, professional preparation, certification status, institutions attended, professional development and technical updating, exposure to energy education, and professional affiliations. These demographic factors were selected as the most appropriate data for clarifying the teachers' roles and for assisting in the identification of "self-renewers" and "entrenchers". The categories of grade levels and subject areas taught presented the most difficult topic to describe as demographic data. The researcher reviewed the 1983-1984 Industrial Education Teacher Directory and constructed a list of potential areas of teaching responsibility.

That list of teaching areas and the number of teachers for each category can be found in Appendix C. Of the approximately 325 industrial arts teachers, only ninety-five teachers were listed as teaching a single craft on the secondary level. Almost double that number, 185 teachers, were listed as having responsibilities that included a comprehensive or general lab as well as single craft labs. Furthermore, a minimum of thirty-seven teachers were listed for both junior and senior high level assignments. These figures were at best approximations, but what they indicated to the researcher was most important. Industrial arts teachers in New Hampshire could not be described as either single craft or comprehensive lab instructors. They are assigned odd combinations of teaching responsibilites that include: junior and senior high levels; comprehensive, dual-craft, single-craft courses; vocational courses; math and science assignments; large, small, private school and hospital settings; primary and secondary areas of responsibility; and administrative roles. Therefore, the researcher included in the demographic questionnaire a comprehensive list of teacher roles.

Renewable Energy Expert Demographic Data

The demographic questionnaire for the renewable energy experts was not constructed for data analysis purposes. Rather, it was developed because the researcher felt that specific personal information about each of the renewable energy experts would assist at a later date in identifying experts who could successfully work with the pool of industrial arts teacher-trainers. In other words, the researcher used the Renewable Energy Survey mailing to gather information relative to the subsequent steps of the WWLM. Specifically, Step VII requires the development (from conceptualization to implementation) of strategies to use interpersonal channels of communication to introduce the new knowledge to the previously identified self-renewers and influentials (teacher-trainers) (Wolf 1983c, pp. 9-10).

The expert demographic questionnaire was field-tested with assistance from the NESEA leadership and can be found in Appendix G.

Identification of Influential Teachers

Phase III. Part II. instrumentation consisted of a simple, sociometric survey form that asked the industrial arts teachers to list the names of five industrial arts colleagues from whom they would prefer to receive in-service training in renewable energy education. Teachers were told to assume that those individuals they nominated were to receive technical updating from experts in renewable energy technology. This last statement was added to the survey based upon the researcher's discussions with the NHIEA leadership, the Industrial Arts Consultant, and several industrial arts teachers throughout the State. It was apparent to these people that only a small number (approximately eight teachers) of the State's industrial arts teachers were involved in energy education, and that the efforts of this small group were not well known to the industrial arts teachers throughout the State.

The sociometric survey therefore meets the specific objective of the study to fulfill Step IV. B.1. and B.2. of the WWLM: "to ascertain who are the 'influentials' and who are the 'isolates' within the targeted audience." (Wolfe 1983c, p. 7)

This survey was included in the teachers' demographic questionnaire which was mailed to teachers along with the Renewable Energy Survey. The survey can be found in Appendix G.

Data Analysis

The similarities and differences between the industrial arts teachers' and the renewable energy experts' opinions of what industrial arts teachers should know in order to teach renewable energy education should have value in and of themselves, both as definitions of needs and as simple comparisons. A rank order correlation coefficient was calculated to test the null hypothesis: There is no relationship between the perceived needs of New Hampshire industrial arts teachers as perceived by the New Hampshire industrial arts teachers and the needs of New Hampshire industrial arts teachers as perceived by New Hampshire-oriented renewable energy experts.

The second major step of the data analysis attempted to determine the degree to which individual industrial arts teachers share similar opinions of their needs for knowledge to teach renewable energy education with the total group of renewable energy experts. In this analysis, the rank order for each element of need definition as provided by a single teacher was correlated with the rank order for each element of need definition as generated by the group of New Hampshire-oriented renewable energy experts. This procedure was repeated for each teacher, and the resultant correlations were used as indices of congruency for the purposes of this study. In other words, these indices of congruency described how closely each teacher shared the perceptions of the experts. This concept was critical to the following two hypotheses and to the screening process for identifying potential teacher-trainers.

The second null hypothesis: There will be no relationship between selected demographic variables (professional development, teaching experience, etc.) and the indices of congruency, was tested for significance by using a stepwise multiple regression procedure. This analysis technique describes the relationships of single or multiple independent variables (demographic factors) to the criterion or dependent variable (measures of congruency) by combining the procedures of correlation and regression. Stepwise multiple regression is a multivariate statistical technique that sequentially tests the predictors and determines the most efficient variables for explaining the variance in the dependent variable. This procedure is not only an effective and powerful hypothesis-testing and inference-making technique, but it also provided clues as to why some industrial arts teachers perceived the needs for renewable energy education knowledge as did the experts. Although causal relationships are not implied by significant correlations, stepwise multiple regression analysis benefited this study's objective of identifying a potential pool of teacher-trainers by providing knowledge about shared demographic relationships concerning their congruency with renewable energy experts in defining the teachers' needs for knowledge about renewable energy.

The stepwise multiple regression technique was also used to test the third null hypothesis: There will be no relationship between the rank orders of influential status of the industrial arts teachers and their congruency with renewable energy experts. The influential status of individual teachers was determined by the number of nominations each teacher received from peers. This nomination process was accomplished by including a brief, sociometric survey in the Teacher Data Sheet, the questionnaire that provided the demographic data (see Appendix G). The purpose of this analysis was to study the predictive value of peer nominations or influential status with regard to teachers' "congruency" with the energy experts.

Furthermore, an analysis of the overlap of two identified groups (those teachers who most closely shared the experts' opinion about needs and those teachers most often selected by their peers as influential) comprised the group of teachers to be targeted as potential teacher-trainers. They shared the biases of the renewable energy experts, and they were respected by their peers as in-service teachers. This group formed the nucleus of "influentials" so critical to the success of the Wolf-Welsh Linkage Methodology in delivering knowledge from the producers to the users. In educational terms, these teacher-trainers would provide the in-service training in renewable energy education to industrial arts teachers in the State of New Hampshire.

CHAPTER IV

RESULTS OF THE RESEARCH AND DATA ANALYSIS

Overview of the Chapter

Energy conservation and renewable energy technology have been targeted for introduction into the industrial arts programs of New Hampshire during the past four years. Efforts to integrate this new technology as subject content into traditional public school curriculum have ranged from state-level policy to individual teachers' efforts. This study was designed to provide data for decision-making that would help to bridge the gap between knowledge producers (renewable energy experts) and knowledge users (industrial arts teachers).

Chapter II outlined a rationale for the inclusion of renewable energy education as an appropriate subject content for industrial arts programs in New Hampshire, and it also introduced a knowledge production/knowledge utilization model as a blueprint for educational change --the Wolf-Welsh Linkage Methodology (WWLM). The researcher reviewed the ten steps of this model (Wolf 1984) and focused on several steps and sub-parts as guidelines for acquiring data for this study.

Chapter III described the research design based upon the criteria specified in the WWLM in four components: 1) sampling, 2) Needs Analysis Methodology (NAM), 3) demographic data, and 4) data analysis. These four components were designed to address the third and fourth objectives of this study. The third objective was the generation of two prioritized lists of needs concerning industrial arts teachers' needs for knowledge in order to teach renewable energy education; the fourth objective involved the identification of potential teacher-trainers from the population of New Hampshire's industrial arts teachers.

This Chapter will present the results of the research, in particular the identification and prioritization of needs as outlined by the NAM and the testing of three hypotheses which attempted to screen potential teacher-trainers. The process of identifying industrial arts teachers' need for knowledge in order to teach renewable energy education as perceived by two groups (the teachers themselves and renewable energy experts) produced 493 needs statements. This list was later prioritized by each group. These two ranked lists--from most important to least important needs statements--provided for both direct face-value comparisons and statistical comparisons.

This Chapter will review these statistical comparisons of teachers' and experts' perceptions of teachers' needs for knowledge. In one case, a rank order correlation was used to test the first null hypothesis that involved the degree of agreement/disagreement between the experts' and teachers' perceptions of teachers' needs for knowledge in order to teach renewable energy education. This group-to-group comparison was followed by a group-to-individual comparison: congruency was a term used to describe the degree to which individual teachers shared the group of experts' perceptions of the relative importance of needs.

The last two sections of the Chapter will report on the testing of the second and third hypotheses as methods for identifying potential teacher-trainers. Both hypotheses involve the relationship between a dependent variable (congruency or influential status) and a group of multiple independent variables (demographic factors). This analysis provided knowledge about shared demographic variables concerning a) individual teachers' congruency with the energy experts in defining teachers' needs for knowledge and b) teachers' selection as "influential" colleagues as nominated by their peers.

In brief, this Chapter will review the results of the NAM which provided the data for determining what knowledge New Hampshire's industrial arts teachers need in order to teach renewable energy education. This Chapter will also describe the results of the data analysis designed to identify a pool of potential teacher-trainers who would help design and provide the in-service training in renewable energy education to the State's industrial arts teachers.

Results of the Identification of Needs

The process for identifying needs followed the standardized, operationalized set of procedures outlined in Sub-set 5.0 Defining of the NAM (Coffing and Hutchinson 1974). Two groups of definers (sixteen industrial arts teachers and sixteen renewable energy experts) provided approximately 1100 discrete need statements. The researcher grouped and sorted these statements and field-tested the list of needs. The final list contained 493 discrete need statements. This list, in and of itself, was a valuable piece of information--both for what was listed and what was not listed (see Appendix E).

The analysis of this list of identified needs was aided by the development of a theoretical framework for organizing this lengthy and diverse group of statements. This framework included eight major categories, and each category is listed below along with the number of needs statements under that heading. The Categories "V. Thermal Applications" and "VI. Solar Electric" were further divided to facilitate this review. The Renewable Energy Survey was split into two survey instruments--Form A consisted of 256 need statements; Form B listed 257 items. Both Form A and Form B included the following theoretical framework both as an introductory "Table of Contents" and as headings throughout the list of need statements to assist respondents.

Table 5

Renewable Energy Survey Framework

	Need Statements Per Section	Percentage of Total List
I. Basic Energy Information: Scientific Background	61	12.4%
II. Basic Energy Information: Implications	36	7.3%
III. Conservation and Renewable Energy: Overview	29	5.9%
IV. Conservation in Practice	38	7.7%

	Need Statements Per Section	Percentage of Total List
V. Thermal Applications	159	32.0%
A. Heating and Cooling	(127)	(25.8%)
B. Heating of Water	(18)	(3.7%)
C. Wood-burning Technology	(14)	(2.8%)
VI. Solar Electric	63	12.8%
A. Photovoltaics	(22)	(4.5%)
B. Windpower	(21)	(4.3%)
C. Hydropower	(20)	(4.1%)
VII. Biomass	20	4.1%
VIII. Delivery of Renewable Energy Education	87	17.6%
Total	493	100.0%

The first notable piece of information was that "Thermal Applications" topics comprised 159 items of the 493-item list, or 32% of the identified needs. Also, a review of the "Conservation in Practice" revealed that the large majority of the needs statements in this section were directly related to the residential/commercial building orientation of the "Thermal Applications" section. In fact, only three needs statements in "Conservation in Practice" were not directly allied with residential/commercial building design and construction: 1) item 80 (Form B)--Industrial and agricultural energy conservation; 2) item 78 (Form A)--Transportation energy conservation; 3) item 79 (Form A)--Organic gardening and its advantages (see Appendix G). Under "Thermal Applications" only a total of nine needs statements were directed beyond residential/commercial thermal concerns: a) items 159 and 160 (Form A) and 159, 160, 161 (Form B)--various aspects of agricultural and industrial process heating; b) 161 (Form A)--Solar kilns and grain dryers; c) 162 (Form A)--cogeneration; a) 134 (Form B)--commercial greenhouses; e) 162 (Form B)--thermal ponds (see Appendix G).

Therefore, the total number of needs statements under the residential/commercial design and construction topic represented 150 of the 159 items under "Thermal Applications" and thirty-five of the thirty-eight items under "Conservation in Practice". This number totaled 185 needs statements or 38% of the items on the list of identified needs.

The second most notable feature of the identified needs list was the relatively low number of items addressing the popular topics in "alternative energy"--windpower, hydropower, photovoltaics, various homeowner energy modifications including wood/solar steam-generated electricity, methane-generated electricity, electric and wind-powered vehicles, and the like. Only sixty-three items or 12.8% of the total needs statements were listed under "Solar Electric", and each subcategory of "Photovoltaics", "Windpower", and "Hydropower" had approximately twenty needs statements (see Table 5). The twenty items under "Biomass" were directed towards commercial/agricultural/industrial applications and simply by-passed the homeowner energy orientation.

Those results of the identification process that were not surprising were the reasonable number of items addressing a) the basics of energy conservation and renewable energy and b) the educational concerns for integrating this subject content into public schools. The basics were addressed by the sections "Basic Energy Information: Scientific Background," "Basic Energy Information: Implications," and "Conservation and Renewable Energy: Overview." These three sections represented 126 needs statements or 25.6% of the total identified needs. "Delivery of Renewable Energy Education" included 87 items or 17.6% of the total identified needs.

Perhaps the most important result of the identification process stemmed from the absence of popular topics that simply were not identified. Specifically, the lack of conservation practices in transportation. Only item 78 (Form A)--Transportation energy conservation--addressed this popular topic. Much publicity since the first energy crisis of 1973-74 has focused on the automobile: importance of regular tune-ups, gas-saving concerns such as properly-inflated tires, wheel alignment, brakes, the 55-mph speed limit, driving habits and the lot. After-market manufacturers of automobile parts have vigorously advertised gas-saving equipment: fuel regulators, better spark plugs, carburetor modifications, and electronic ignition system components. Automobile manufacturers, both foreign and domestic, have at various times in the past ten years promoted a wide variety of fuel-efficient designs and components: four-cycle, overhead cam engines, V-6 engines as V-8 engine replacements, electronic ignition systems, fuel injection systems, computer-assisted ignition systems, turbochangers, lighter vehicle size and weight, aerodynamic designs and more.

In addition to a plethora of full-saving designs and equipment modifications widely publicized by both foreign and domestic automobile manufacturers, major advancements in energy conservation have been promoted by other transportation industries during the past decade. Aircraft manufacturers have been describing more fuel-efficient engines and aircraft designs. Railroads have reminded the public that passenger and freight service are for more energy-efficient modes of transportation compared to passenger cars, freight-hauling trucks and aircraft. Large urban transportation systems have been updated with modernized versions of commuter and subway trains, and these projects have been described as energy-efficient people-moving systems.

The scope of these and similar energy conservation efforts initiated by the transportation sector far outstrip the range of this study. But the magnitude of these efforts must be recognized in order to report the important fact that despite the large number of energy conservation measures advertized by the transportation sector, the definers identified only one need statement, a generic statement, covering the topic of transportation energy conservation. It is also important to note that seven of the sixteen teacher-definers (168, 044, 198, 138, 215, 324, 311) had primary or secondary teaching responsibilities in the Energy and Power cluster (which includes the traditional areas of automechanics) and that one of these seven teacher-definers (311) taught automechanics as a primary teaching responsibility (see Appendix C).

The above four observations of the list of identified needs provide evidence for the following conclusion: energy conservation and renewable energy conservation technology as a content area in industrial arts education does not fit neatly into the State of New Hampshire's Energy and Power cluster. First of all, based on the list of identified needs, thirty-eight percent of the statements were directly related to residential/commercial design and construction; in other words, thirty-eight percent of the needs list referred to knowledge needed by industrial arts teachers working in the Materials and Process Technology cluster (building construction) or in the Visual Communication Technology cluster (architectural drafting).

Secondly, only 12.8 percent of the needs statements addressed the popular topics in "alterntive energy"--windpower, hydropower, photovoltaics and other electricity producing systems. Traditionally, these technological areas have been allied most closely with the commonly recognized areas in the Energy and Power cluster--power mechanics, electricity, electronics, and transportation. And perhaps even more importantly, only one need statement singled out energy conservation in transportation.

The fourth observation involved the number of items addressing a) the basics of energy conservation and renewable energy (25.6%) and b) the educational issue of integrating this subject content into industrial arts programs (17.6%). The needs statements in these categories stressed the need for teachers' knowledge of basic scientific principles, basic energy issues, and content delivery concerns. These needs statements reflected a concern for both the "basics" and teaching resources and strategies. Therefore, 43.2 percent of the needs statements could be viewed as a knowledge foundation for all industrial arts teachers who, regardless of their subject content or cluster orientation, are planning to integrate energy conservation and renewable energy technology into their courses or programs.

Thus the list of identified needs proved to be valuable in defining industrial arts teachers' needs for knowledge to teach energy conservation and renewable energy technology. The most notable conclusion to be drawn from a face-value observation of the list of needs statements was that the teachers' need for knowledge as identified by the definers did not stress knowledge of Power and Energy cluster-oriented technology. In fact, the list of teachers' needs for knowledge indicated a need for knowledge in scientific basics, general issues, delivery concerns, and a wide range of specific technologies subsumed under all three cluster areas.

The ultimate value of this list of identified needs does not pertain solely to the above discussion. The list was compiled to meet the objectives of the Wolf-Welsh Linkage Methodology (WWLM) listed under "Step II. Identification of a Targeted Audience's Need to Modify Some Aspect or Aspects of Professional Practice." This list was used as a base, as a point of departure for establishing two prioritized lists of needs as determined by the two separate groups--the industrial arts teachers and the renewable energy experts. The description of the results of this prioritization process is offered in the next section of this Chapter.

Results of the Prioritization of Needs

The prioritization of needs statements produced two separate lists of priority rankings, one list ranked by renewable energy experts and the other list ranked by New Hampshire's industrial arts teachers. These two prioritized lists of needs statements represented the most important data for the purposes of this study. The following analysis of these data is organized into four parts: 1) a description of the experts' thirty highest ranked needs statements, 2) a description of the teachers' thirty highest ranked needs statements, 3) a face-value comparison of the two lists of the thirty highest ranked items, and 4) a summary. The decision to focus on the thirty needs statements ranked highest by the two groups was based on practicality. The ultimate value of the two lists would be realized from the submission of these data to the "targeted audience" as described by the WWLM in Part II. Subparts C. and D.

It should be noted that the Appendix I contains all the figures, priority lists, and appropriate computer printouts referred to in the subsequent discussions.

The following chart, Table 6, was based on the Renewable Energy Survey framework and its eight major headings or categories (see Appendix E). This framework was chosen as a format for analyzing the thirty needs statements ranked highest by the experts. Table 6

Analysis of Priority Rankings: Energy Experts has the survey framework positioned on the right side, and the priority number of the thirty highest ranked needs statements. Table 6 then provides information about the number and priority rankings of the experts' thirty highest ranked need statements in relation to the various content categories.

Table 6

Analysis of Priority Rankings: Energy Experts

Ranking by Experts	Category
	I. Basic Energy Information: Scientific Background
21.	A. Energy and Power
7.	B. Heat Energy
	C. Energy Generation, Storage, Conversion, Distribution
22.	D. Science Support
	II. Basic Energy Information: Implications
5.9.	A. History
	B. Supply & Demand
1.	C. Economics
	D. Politics
	E. Social
29.	F. Environmental Concerns
28.	G. Specific Issues
	III. Conservation and Renewable Energy: Overview
18.	A. History
	B. Economics
	C. Politics
	D. Social
	E. Environmental
10.	F. Specific Issues
8.	G. Science Support

Ranking by Experts	Category
IV.	Conservation in Practice
13.	A. Definitions
	B. Economics
24.30.	C. Residential/Commercial Buildings
	D. Transportation
	E. Industrial
	F. Agricultural
	G. Specific Issues
	V. Thermal Applications
	A. Heating and Cooling
3.12.17.25.	1. Design
6.11.	2. Passive
16.	3. Active
2.	4. HVAC
20.	5. Insulation
	6. Vapor Barriers
	7. Glazings
	8. Air: Air Exchangers
	9. Sunspace/Greenhouse
	10. Construction Skills
	B. Heating of Water
23.	1. Design
	2. Passive
	3. Active
	4. HVAC
	5. Installation
	C. Wood-Burning Technology (space-heating, agricultural and industrial process heating)
	1. Wood-burning technology
	2. Agricultural/industrial process heating
	VI. Solar Electric
	A. Photovoltaics
15.	1. Basics
	2. Economics
	3. Installation
	4. Specifics
	B. Windpower
27.	1. Basics
	2. Economics
	3. Installation
	4. Specifics

Ranking by Experts	Category
	C. Hydropower
4.	1. Basics
	2. Economics
	3. Installation
	4. Specifics
	VII. Biomass
19.26.	A. Basics
	B. Economics
	C. Installation
	D. Specifics
	VIII. Delivery of Renewable Energy Education in Industrial Arts
14.	A. Definitions
	B. Curriculum
	C. Direct Delivery Methods
	D. Technical Support
	E. Teacher Skills

The experts' top thirty ranked needs statements can be discussed in the context of three observations of Table 6. Fourteen of the top rankings (priorities 1., 5., 7., 8., 9., 10., 13., 18., 21., 22., 24., 28., 29., 30.) can be categorized as "basics" because they appeared under the following framework headings: I. Basic Energy Information: Scientific Background, II. Basic Energy Information: Implications, III. Conservation and Renewable Energy: Overview, and IV. Conservation in Practice. The experts, therefore, recognized the industrial arts teachers' need for knowledge of basic scientific principles, supply and demand concepts, and definitions of appropriate strategies.

The second observation is that in terms of knowledge of specific applications, the experts felt that teachers needed to be well-grounded in design principles and construction skills for residential/commercial construction. Priorities 2., 3., 6., 11., 12., 16., 17., 20., 23., 25. all appeared under V. Thermal Applications, and all but one (priority 23. was listed under B. Heating of Water--1. Design) were listed under A. Heating and Cooling. The experts clearly expressed a commonality of opinion on teachers' needs for knowledge in this area of building design and technology.

A third observation was that the experts felt that teachers need a basic understanding of photovoltaics, windpower, hydropower, and biomass. The level of these ranking (15., 27., 4., 19. and 26. respectively) underscored the predominance of "basics" in the experts' opinions, with the exception of specific technologies in residential/commercial contruction. It is interesting that in terms of "delivery", the experts again ranked high a knowledge of the basics; the fourteenth ranked item was item #206 in RES Form B, "A progression of energy awareness activities starting in the elementary schools."

The following chart, Table 7, lists each need statement in the priority ranking order, one through thirty. The reader can review this list of needs statements to gain a clearer picture of the experts' perceptions. For instance, the number one need as ranked by the experts was item #75 on the master list of 493 needs statements that appeared as question #38 on Form A on the Renewable Energy Survey.

Table 7

Expert Priority List

Priority	Master List Number	RES A or B and Number
1	75	A - 38

A clear understanding of energy economics so that alternative solutions can be compared and realistic options explored, e.g., first year cost, first year savings, years to payback, rate of return, cost benefit ratio, life cycle cost.

2	228	A - 114

Review of all types of heating systems, e.g., passive and active solar; resistance electric and radiant electric; efficient gas furnaces; wood-burning stoves and boilers; air conditioners and heat pumps.

3	166	A - 82

Designing and constructing energy-efficient buildings (heating/ cooling), including reducing square footage, maximizing space utilization, overhangs, etc..

4	369	B - 185

Hydropower, principles of operation, basics of power production.

5	64	B - 31

Historical overview of all energy sources, supplies and demands in order to understand the validity of the energy crisis on a worldwide basis (e.g.: Hubbert's Law, exponential growth, availability of purchased energy, projections).

6	208	A - 104

Direct gain fundamentals in passive solar design, e.g., what is it and how does it work; performance versus glazing type in NE; importance of overheating controls (mass, aperature sizing); orientation versus performance, simple design patterns.

7	21	A - 10

The physics of heat transfer (radiation, conduction, and convection).

8	124	A - 62

Basics of solar energy, including availability, quality, climate dependent variables, the relationship between end use and efficiency.

Priority	Master List Number	RES A or B and Number
9	63	A - 32

Basic history of energy sources and their uses, including efficiencies, costs, environmental and political impact as sources and as end products.

10	121	B - 60

The energy resources of New Hampshire, including renewable sources compared to the State's importation of energy.

11	201	B - 101

Use and design of passive solar energy systems in house construction for space heating and cooling; e.g., thermal comfort, site analysis, building form and orientation, building envelope strategies, ventilation, shading, vegetation, construction.

12	176	A - 87

Basics of solar radiation, including sunpaths versus time of day, season, etc.; true versus magnetic north; maximum power available.

13	128	B - 65

Ways to conserve energy.

14	411	B - 206

A progression of energy awareness activities starting in the elementary schools.

15	325	A - 163

Basic principles of direct conversion of sunlight to electricity using semi-conductors/silicon-based solar cells.

16	224	A - 112

Solar collector fundamentals, e.g., different kinds--air, liquid, flat plate, concentrators; advantages and disadvantages; absorbers/ coatings; transfer media; isulation options; glazings.

17	169	B - 85

Basic understanding of home heating and cooling systems, especially with regard to their use in highly insulated buildings.

18	101	B - 50

Understanding and appreciation of the role of energy conservation in the scheme of helping to balance our nation's energy needs with the available resources.

Priority	Master List Number	RES A or B and Number

19 389 B - 195
Readily available fuel sources, including animal waste, garbage, grain products, wood/chips/pellets, bagasse, vegetable fibers, peat, sewage sludges, etc..

20 237 B - 119
Complete understanding of R-factors, U-value, k,C.

21 3 A - 2
Elements and applications of thermodynamics, including the first and second laws of thermodynamics.

22 42 B - 21
Basic physics.

23 302 A - 152
Fundamentals of hot water solar collectors, e.g., different types; advantages and disadvantages; absorbers/coatings, glazing, insulation, and media options.

24 154 B - 78
Conservation measures for existing homes, including caulking, foaming, weatherstripping, adding insulation, etc..

25 174 A - 86
Practical information from the field on difficulties with new materials and devices, such as ridge venting, vapor barriers, double-wall construction, heat exchangers, special wiring runs, etc.

26 388 A - 194
Basic information framework in biogas extraction from organic wastes, including biomass types, combustion theory, physical chemistry, biological conversion systems, gas extraction.

27 347 B - 174
The how's and why's of windpower.

28 86 B - 42
Views of the larger picture: energy is intertwined with social, political, economic, cultural, environmental issues.

29 79 A - 40
The environmental impact of all energy sources.

Priority	Master List Number	RES A or B and Number
30	143	A - 70

Unwanted heat transfer, including building envelope losses (infiltration, conduction, effects of thermal mass).

A description of the teachers' thirty highest ranked needs statements can be accomplished by a similar review of the following complementary charts, Table 8 Analysis of Priority Rankings: IA Teachers and Table 9 Teacher Priority List. For example, according to Table 9 Teacher Priority List, the teachers ranked as their top priority item #155 from Form B, "Pro's and con's of burning wood for space heating." This particular need statement was listed under II. Thermal Applications, C. Wood-burning Technology in Form B, and therefore, this top-ranked item is matched with the same category/subpart in Table 8 Analysis of Priority Rankings: IA Teachers.

Table 8

Analysis of Priority Rankings: IA Teachers

Ranking by Teachers	Category
	I. Basic Energy Information: Scientific Background
28.	A. Energy and Power
	B. Heat Energy
	C. Energy Generation, Storage, Conversion, Distribution
	D. Science Support

Ranking by Teachers	Category
	II. Basic Energy Information: Implications
9.12.	A. History
29.	B. Supply & Demand
	C. Economics
	D. Politics
	E. Social
	F. Environmental Concerns
	G. Specific Issues
	III. Conservation and Renewable Energy: Overview
	A. History
	B. Economics
	C. Politics
	D. Social
	E. Environmental
	F. Specific Issues
26.	G. Science Support
	IV. Conservation in Practice
3.17.	A. Definitions
	B. Economics
13.21.22.	C. Residential/Commercial Buildings
	D. Transportation
	E. Industrial
	F. Agricultural
	G. Specific Issues
	V. Thermal Applications
	A. Heating and Cooling
23.	1. Design
	2. Passive
	3. Active
4.	4. HVAC
	5. Insulation
	6. Vapor Barriers
	7. Glazings
	8. Air: Air Exchangers
	9. Sunspace/Greenhouse
	10. Construction Skills

Ranking by Teachers	Category
	B. Heating of Water
	1. Design
	2. Passive
	3. Active
	4. HVAC
	5. Installation
	C. Wood-Burning Technology (space-heating, agricultural and industrial process heating)
1.10.	1. Wood-burning technology
	2. Agricultural/industrial process heating
	VI. Solar Electric
	A. Photovoltaics
11.	1. Basics
	2. Economics
	3. Installation
	4. Specifics
	B. Windpower
2.7.	1. Basics
	2. Economics
	3. Installation
	4. Specifics
	C. Hydropower
5.27.	1. Basics
	2. Economics
	3. Installation
	4. Specifics
	VII. Biomass
8.	A. Basics
	B. Economics
	C. Installation
	D. Specifics
	VIII. Delivery of Renewable Energy Education in Industrial Arts
20.	A. Definitions
6.15.19.24.	B. Curriculum
16.25.	C. Direct Delivery Methods
14.18.	D. Technical Support
	E. Teacher Skills

Table 9

Teacher Priority List

Priority	Master List Number	RES A or B and Number
1	311	B - 155
Pro's and con's of burning wood for space heating.		
2	347	B - 174
The how's and why's of windpower.		
3	128	B - 65
Ways to conserve energy.		
4	228	A - 114
Review of all types of heating systems, e.g., passive and active solar; resistance electric and radiant electric; efficient gas furnaces and oil furnaces; wood-burning stoves and boilers; air conditioners and heat pumps.		
5	369	B - 185
Hydropower, principles of operation, basics of power production.		
6	414	A - 207
A syllabus of what should be covered in renewable energy education.		
7	348	A - 174
Different types of windmills in terms of air foil/rotor design.		
8	389	B - 195
Readily available fuel sources, including animal waste, garbage, grain products, wood/chips/pellets, bagasse, vegetable fibers, peat, sewage sludges, etc..		
9	63	A - 32
Basic history of energy sources and their uses, including efficiencies, costs, environmental and political impact as sources and as end products.		
10	312	A - 157
Basic safety concerns with heating with wood.		
11	325	A - 163
Basic principles of direct conversion of sunlight to electricity using semi-conductors/silicon-based solar cells.		

Priority	Master List Number	RES A or B and Number
12	64	B - 31

Historical overview of all energy sources, supplies and demands in order to understand the validity of the energy crisis on a worldwide basis (e.g.: Hubbert's Law, exponential growth, availability of purchased energy, projections).

13	144	B - 73

Energy conservation in the home.

14	447	B - 224

Appropriate courses, seminars, etc. held at colleges for teacher in-service, updating.

15	410	A - 205

Location of teaching resources, including texts and software.

16	419	B - 210

Plans to construct teaching aids, simple/student projects, show-and-tell working models which demonstrate appropriate concepts.

17	129	A - 63

Energy saving equipment, technology, and trends.

18	452	A - 227

Alternative energy newsletter to keep IA teachers informed of the latest happenings.

19	409	B - 205

Access to exemplary projects/curriculum.

20	408	A - 204

Broad definition of renewable energy education including a listing of all areas that would be included in the definition.

21	153	A - 75

Retrofitting 1950 houses for energy available in the 1990's.

22	149	A - 73

Where and when to insulate.

23	169	B - 85

Basic understanding of home heating and cooling systems, especially with regard to their use in highly insulated buildings.

Priority	Master List Number	RES A or B and Number
24	415	B - 208
An ideal curriculum in renewable energy education that would act as a base and could be updated.		
25	441	B - 221
Inexpensive experiments that can be conducted in the classroom.		
26	124	A - 62
Basics of solar energy, including availability, quality, climate dependent variables, the relationship between end use and efficiency.		
27	368	A - 184
Availability of water as a power source (including all forms from low-head hydro to gulf stream).		
28	5	A - 3
Units of energy measurement (e.g., BTU, KWHr., ft-lbs, HP, conversions, etc.).		
29	68	B - 33
Understanding and appreciation of all sources of energy.		
30	201	B - 101
Use and design of passive solar energy systems in house construction for space heating and cooling; e.g., thermal comfort, site analysis, building form and orientation, building envelope strategies, ventilation, shading, vegetation, construction.		

The teachers' rankings are perhaps also best discussed as a series of observations. The teachers obviously felt that knowledge of the burning of wood for space heating was of real importance. "Pro's and con's of burning wood for space heating" ranked first, and "basic safety concerns with heating with wood" ranked tenth. A second observation was that the teachers were very much concerned about strategies for implementing renewable energy technology as a subject content. Nine priorities (6., 14., 15., 16., 18., 19., 20., 24., 25.)

were listed under VIII. Delivery of Renewable Energy Education in Industrial Arts.

In terms of specific technologies, the teachers ranked windpower the greatest need (2. and 7.), followed by residential/commercial heating and cooling design and systems (4., 23., 30.), hydropower basics (5., 27.), photovoltaics (11.), and conservation practices for homes (13., 21., 22.). The basics of renewable energy technology were weighted somewhat behind the issues of burning wood, educational delivery, and specific technologies. Six items were ranked third through seventeenth in the first three categories plus subpart A. Definitions under Category IV. Conservation in Practice.

The third step of this analysis of the experts and teachers thirty highest ranked items can be facilitated by combining Tables 6 and 8. The resultant chart is Table 10. Analysis of Priority Rankings: Energy Experts and IA Teachers. Based on this format, a comparison of the experts and teachers lists of the thirty highest ranked items reveals some difference of opinion.

Table 10

Analysis of Priority Rankings: Energy Experts and IA Teachers

Ranking by Experts	Ranking by Teachers	
		I. Basic Energy Information: Scientific Background
21.	28.	A. Energy and Power
7.		B. Heat Energy
		C. Energy Generation, Storage, Conversion, Distribution
22.		D. Science Support

Ranking by Experts	Ranking by Teachers	
		II. Basic Energy Information: Implications
5.9.	9.12.	A. History
	29.	B. Supply & Demand
1.		C. Economics
		D. Politics
		E. Social
29.		F. Environmental Concerns
28.		G. Specific Issues
		III. Conservation and Renewable Energy: Overview
18.		A. History
		B. Economics
		C. Politics
		D. Social
		E. Environmental
10.		F. Specific Issues
8.	26.	G. Science Support
		IV. Conservation in Practice
13.	3.17.	A. Definitions
		B. Economics
24.30.	13.21.22.	C. Residential/Commercial Buildings
		D. Transportation
		E. Industrial
		F. Agricultural
		G. Specific Issues
		V. Thermal Applications
		A. Heating and Cooling
3.12.17.25.	23.	1. Design
6.11.	30.	2. Passive
16.		3. Active
2.	4.	4. HVAC
20.		5. Insulation
		6. Vapor Barriers
		7. Glazings
		8. Air: Air Exchangers
		9. Sunspace/Greenhouse
		10. Construction Skills

Ranking by Experts	Ranking by Teachers	
		B. Heating of Water
23.		1. Design
		2. Passive
		3. Active
		4. HVAC
		5. Installation
		C. Wood-Burning Technology (space-heating, agricultural and industrial process heating)
	1.10.	1. Wood-burning technology
		2. Agricultural/industrial process heating
	VI.	Solar Electric
		A. Photovoltaics
15.	11.	1. Basics
		2. Economics
		3. Installation
		4. Specifics
		B. Windpower
27.	2.7.	1. Basics
		2. Economics
		3. Installation
		4. Specifics
		C. Hydropower
4.	5.27.	1. Basics
		2. Economics
		3. Installation
		4. Specifics
	VII.	Biomass
19.26.	8.	A. Basics
		B. Economics
		C. Installation
		D. Specifics
	VIII.	Delivery of Renewable Energy Education in Industrial Arts
14.	20.	A. Definitions
	6.15.19.24.	B. Curriculum
	16.25.	C. Direct Delivery Methods
	14.18.	D. Technical Support
		E. Teacher Skills

A review of the experts' and teachers' lists of the thirty highest ranked items reveals some differences of opinion. The experts simply did not rank highly the need for knowledge about space-heating with wood-burning appliances. The experts also did not share the teachers' opinion about the need for knowledge about methods for integrating renewable energy education in industrial arts programs. In terms of photovoltaics, windpower, hydropower, and biomass, the teachers ranked knowledge of these specific technologies higher than did the experts. The teachers were also more concerned about knowledge of conserving energy in existing residences. The teachers ranked item #65 on RES form B "ways to conserve energy" third; the experts ranked the same item thirteenth. Additionally, the teachers ranked four other items (priorities 13., 17., 21., 22.) under IV. Conservation in Practice, and the experts two other needs statements (priorities 24., 30.).

For the experts, the scientific and conceptual basics of renewable energy education as well as a variety of concerns in residential/commercial building design and construction were a major focus of their highest ranked items. The teachers recognized these areas as important, but not as important as wood-burning technology, educational delivery, and more popular alternative energy sources such as windpower, hydropower, photovoltaics, and biomass.

Certain patterns appeared during the previous face-value description of the experts' and teachers' rankings. The expert and teacher groups did not share the same rankings for all of the categories of knowledge areas. However, despite the differences in these rankings, there were also several common grounds of agreement in these top thirty rankings. Further analysis of these rankings was required to distinguish among the various areas of agreement and disagreement. The next two charts, Table 11 and Table 12 compare the expert and teacher rankings of the top thirty ranked items for each group. Table 11 compares the expert group's top thirty choices with the teachers' rankings for each of the same thirty needs statements; Table 12 compares the teachers' thirty highest ranked items with the experts' ranking for each of the same thirty needs statements. The first chart to be discussed is Table 11.

Table 11

Comparisons of Expert and Teacher Rankings: Experts' Rankings as The Base

RES A or B and Number	Need Statement	Ranking by Experts	Ranking by Teachers
A-38	A clear understanding of energy economics.....	1	71
A-114	Review of all types of heating systems.....	2	4
A-82	Designing and constructing energy-efficient buildings.....	3	32
B-185	Hydropower, principles of operation.....	4	5
B-31	Historical overview of all energy sources.....	5	12
A-104	Direct gain fundamentals in passive solar design.....	6	129
A-10	The physics of heat transfer.....	7	87

RES A or B and Number	Need Statement	Ranking by Experts	Ranking by Teachers
A-62	Basics of solar energy.....	8	26
A-32	Basic history of energy sources.....	9	9
B-60	The energy resource of New Hampshire.....	10	37
B-101	Use and design of passive solar energy systems.....	11	30
A-87	Basics of solar radiation.....	12	94
B-65	Ways to conserve energy.....	13	3
B-206	A progression of energy awareness activities.....	14	79
A-163	Basic principles of direct conversion of sunlight to electricity.....	15	11
A-112	Solar collector fundamentals.....	16	170
B-85	Basic understanding of home heating and cooling systems.....	17	23
B-50	Understanding and appreciation of the role of energy conservation.....	18	62
B-195	Readily available fuel sources [biomass].....	19	8
B-119	Complete understanding of R-factors.....	20	34
A-2	Elements and applications of thermo-dynamics.....	21	336
B-21	Basic physis.....	22	172
A-152	Fundamentals of hot water solar collectors.....	23	33
B-78	Conservation measures for existing homes.....	24	45

RES A or B and Number	Need Statement	Ranking by Experts	Ranking by Teachers
A-86	Practical information from the field.....	25	89
A-194	Basic information framework in biogas.....	26	41
B-174	The how's and why's of windpower.....	28	354
B-42	Views of the larger picture.....	29	49
A-40	The environmental impact of all energy sources.....	29	49
A-70	Unwanted heat transfer.....	30	164

Based upon Table 12, it was determined that eleven of the top expert-ranked need statments were also ranked in the top thirty by the teachers:

Table 12

Areas of Agreement (Expert Base)

Need Statement	Expert Ranking	Teacher Ranking
A-114	2	4
B-185	4	5
B-31	5	12
A-62	8	26
A-32	9	9
B-101	11	30
B-65	13	3
A-163	15	11
B-85	17	23
B-195	19	8
B-174	27	2

Additionally, there were seven items that the experts ranked in the top thirty that the teachers also ranked comparatively high:

Table 13

Additional Areas of Agreement (Expert Base)

Need Statement	Expert Ranking	Teacher Ranking
A-82	3	32
B-60	10	37
B-119	20	34
A-152	23	33
B-78	24	45
A-194	26	41
A-40	29	49

This review of these eighteen need statements that were ranked similarly by both the expert and teacher groups indicated that the two groups shared many perceptions of what teachers need to know in order to teach renewable energy technology.

On the other hand, several areas of disagreement were also evidenced by the discrepancies of rankings. For twelve of the experts' top thirty ranked items were ranked far lower by the teacher group.

Table 14

Areas of Disagreement (Expert Base)

Need Statement	Expert Ranking	Teacher Ranking
A-38	1	71
A-104	6	129
A-10	7	87
A-87	12	94

Need Statement	Expert Ranking	Teacher Ranking
B-206	14	79
A-112	16	170
B-50	18	62
A-2	21	336
B-21	22	172
A-86	25	89
B-42	28	354
A-70	30	164

The differences between expert and teacher perceptions were magnified by this analysis of discrepancies. The experts ranked as much more important scientific principles, quantitative skills, and cenceptual frameworks--what could be called the "basics" of renewable energy technology. The examples of this differentiation were self-evident:

1) A-38 A clear understanding of energy economics.....

2) A-104 Direct gain fundamentals in passive solar design.....

3) A-10 The physics of heat transfer.....

4) A-87 Basics of solar radiation.....

5) A-112 Solar collector fundamentals.....

6) B-50 Understanding and appreciation of the role of energy conservation...

7) A-2 Elements and applications of thermodynamics.....

8) B-1 Basic physics.....

9) B-42 Views of the larger picture.....

10) A-90 Unwanted heat transfer.....

The only two needs statements not directly related to "basics" that the experts ranked considerably higher than the teachers involved technical updating (A-86 "Practical information from the field....") and educational delivery (B-206 "A progression of energy awareness activities....."). In both cases, the teachers ranking of similar need statements conformed to the experts' selection of A-86 and B-206. In terms of "practical information from the field," the teachers ranked highly A-227 "Alternative energy newsletter to keep IA teachers informed of the latest happenings" and B-224 "appropriate courses, seminars, etc. held at colleges for teachers in-service, updating." The teachers apparently perceived technical updating as a high priority although they did rank A-86 in the 89th position. Likewise, the teachers expressed their concern for industrial arts teachers' need for knowledge of educational strategies. The teachers ranked B-206 in the 79th position, but they also ranked nine other needs statements under VIII. Delivery of Renewable Energy Education in Industrial Arts in the top thirty positions. Therefore, it can be argued that the teachers did in fact share the experts' concern for technical updating and knowledge of delivery strategies. The real area of disagreement stems from the experts perception that a strong background in scientific principles, quantitative analysis, and conceptual bases for renewable energy technology are keys to teachers' preparation to teach renewable energy education.

A similar analysis of the second chart, Table 15 also provided information about areas of agreement and disagreement:

Table 15

Comparisons of Expert and Teacher Rankings:
Teacher's Rankings as the Base

RES A or B and Number	Need Statement	Ranking by Teachers	Ranking by Experts
B-155	Pro's and con's of burning wood.....	1	41
B-174	The how's and why's of windpower.....	2	27
B-65	Ways to conserve energy.....	3	13
A-114	Review of all types of heating systems.....	4	2
B-185	Hydropower, principles of operation.....	5	4
A-207	A syllabus of what should be covered in renewable energy education.....	6	112
A-174	Different types of windmills.....	7	188
B-195	Readily available fuel sources [biomass].....	8	19
A-32	Basic history of energy sources.....	9	9
A-157	Basic safety concerns with heating with wood.....	10	32
A-163	Basic principles of direct conversion.....	11	15
B-31	Historical overview of all energy sources.....	12	5
B-73	Energy conservation in the home.....	13	87
B-224	Appropriate courses, seminars.....	14	316
A-205	Location of teaching resources.....	15	129
B-210	Plans to construct teaching aids.....	16	84
A-63	Energy saving equipment.....	17	50
A-227	Alternative energy newsletter.....	18	159

RES A or B and Number	Need Statement	Ranking by Teachers	Ranking by Experts
B-205	Access to exemplary projects/ curriculum.....	19	84
A-204	Broad definition of renewable energy education.....	20	104
A-75	Retrofitting 1950's houses.....	21	103
A-73	Where and when to insulate.....	22	62
B-85	Basic understanding of home heating and cooling systems.....	23	17
B-208	An ideal curriculum in renewable energy education.....	24	63
B-221	Inexpensive experiments.....	25	170
A-62	Basics of solar energy.....	26	8
A-184	Availability of water as a power source.....	27	137
A-3	Units of energy measurement.....	28	36
B-33	Understanding and appreciation of all sources of energy.....	29	143
B-101	Use and design of passive solar energy systems.....	30	11

Based upon the above Table 15, it was determined that eleven of the top teacher-ranked need statements were also ranked in the top thirty by the experts:

Table 16

Areas of Agreement (Teacher Base)

Need Statement	Teacher Ranking	Expert Ranking
B-174	2	27
B-65	3	13
A-114	4	2
B-185	5	4
B-195	8	19
A-32	9	9
A-163	11	15
B-31	12	5
B-85	23	17
A-62	26	8
B-101	30	11

These eleven "matches" are the same matched items discussed previously, except the teachers' rankings are used as the base. There were also six need statements that were ranked in the top thirty by the teachers that were also ranked relatively high by the experts:

Table 17

Additional Areas of Agreement (Teacher Base)

Need Statement	Teacher Ranking	Expert Ranking
B-155	1	41
A-157	10	32
A-63	17	50
A-73	22	62
B-208	24	63
A-3	28	36

Given these paired rankings with relatively small discrepancies, it was determined that thirteen of the teachers' highest ranked items were ranked considerably lower by the experts:

Table 18

Areas of Disagreement (Teacher Base)

Need Statement	Teacher Ranking	Expert Ranking
A-207	6	112
A-174	7	188
B-73	13	87
B-224	14	316
A-205	15	129
B-210	16	84
A-227	18	159
B-205	19	84
A-204	20	104
A-75	21	103
B-221	25	170
A-184	27	137
B-33	29	143

A review of these last thirteen need statements indicated that the teachers' perceived industrial arts teachers need for knowledge of appropriate curriculum material, teaching strategies, and classroom activities as far more important than did the experts. The following eight need statements from this group of thirteen items cover comprehensively the category VIII. Delivery of Renewable Energy Education in Industrial Arts:

1) A-207 A syllabus of what should be covered in renewable energy education.

2) B-224 Appropriate courses, seminars, etc. held at colleges for teaching resources, including texts and software.

3) A-205 Location of teaching resources, including texts and software.

4) B-210 Plans to construct teaching aid, simple/student projects, show-and-tell working models which demonstrate appropriate concepts.

5) A-227 Alternative energy newsletter to keep IA teachers informed of the latest happenings.

6) B-205 Access to exemplary projects/curriculum.

7) A-204 Broad defintion of renewable energy education including a listing of all areas that would be included in the definition.

8) B-221 Inexpensive experiments that can be conducted in the classroom.

Of the remaining five need statements ranked far differently by the teachers and experts, two items dealt with alternative energy sources utilized as electricity-generating technologies. The teachers' high ranking of A-174 "Different types of windmills in terms of air foil/rotor design." and A-184 "Availability of water as a power source (including all forms from low-head hydro to gulf stream)" reinforced the conclusion drawn previously. Overall, the teachers ranked higher the more "popular" technologies--photovoltaics, wind-power, hydropower, biomass--than did the experts. Therefore, the discrepancy in rankings for A-174 and A-184 was consistent with the previous interpretation.

The last three need statements with marked ranking discrepancies represented more the teachers' concern for the status quo that there was any major difference in the perceptions of the two groups. The teachers ranked B-33 "Understanding and appreciation of all sources of energy" in the 29th position, the experts ranked it 143rd. However, both groups ranked similar needs statements concerning overviews of all sources of energy in the top thirty items. A-32 "Basic history of energy sources and their uses, including efficiences, costs, environmental and political impact as sources and as end products" was ranked ninth by both groups. B-31 "Historical overview of all energy sources, supplies and demands in order to understand the validity of the energy crisis on a worldwide basis (e.g.: Hubbert's Law, exponential growth, availability of purchased energy, projects)" was ranked fifth by the experts and twelth by the teachers. Therefore, the significance of the discrepancy for the ranking of B-33 was tempered by the agreement of teachers and experts on other directly related need statements.

Likewise, the teachers ranked B-73 "Energy conservation in the home" thirteenth and A-75 "Retrofitting 1950 houses for energy available in the 1990's" twenty-first. The experts ranked B-73, 87th and A-75, 103rd. However, the experts ranked high other need statements that involve retrofitting residential structures: priority 1/A-38 "A clear understanding of energy economics....."; priority 2/A-114 "Review of all types of heating systems....."; priority 6/A-104 "Direct gain fundamentals in passive solar design....."; priority 13/B-65 "Ways to conserve energy."; priority 16/A-112 "Solar collector fundamentals....."; priority 23/A-152 "Fundamentals of hot water collectors...."; priority 24/B-78 "Conservation measures for existing homes, including caulking, foaming, weatherstripping, adding insulation, etc."; priority 30/A-70 "Unwanted heat transfer, including building envelope losses". Therefore, the discrepancies of the rankings for B-73 and A-75 did not reflect substantial differences of opinion between the teacher and expert groups concerning the industrial arts teachers' need for knowledge about retrofitting strategies for residential structures.

In summation, the expert and teachers shared to a large degree similar perceptions of what New Hampshire's industrial arts teachers need to know in order to teach energy conservation and renewable energy technology. The areas of discrepancy were differentiated as follows. First, the experts stressed the need for a comprehensive, in-depth knowledge base in the scientific principles, quantitative analysis, and conceptual foundations of renewable energy technology. The teachers recognized the areas of conceptual foundations, but the teachers as a group stressed educational delivery--curriculum, strategies, methods, activities--over the importance of a more basic, science-oriented knowledge base. Secondly, in the need for knowledge of specific renewable energy technologies, the experts ranked building design and construction items much higher than did the teachers. The teachers, instead, recognized wood-burning for space heating and retrofitting strategies for existing homes, but their evaluation placed greater emphasis on more "popular" or more "glamorous" electricity-producing alternative energy technologies such as photovoltaics, windpower, hydropower, and biomass.

The practical application of this analysis of the expert and teacher rankings extends beyond the previous discussions. These two priority lists represent a powerful data base for decision-making. As outlined earlier in this report, the Wolf-Welsh Linkage Methodology (WWLM) was selected as a blueprint for educational change. In the WWLM, Step II C. specifies that a list of the identified needs of a targeted group must be created and that this list should be distributed to the targeted audience for the purpose of prioritizing.

Additionally, the WWLM suggests that the members' responses should be used as "a point of departure for establishing a prioritized list of needs" and that various members of the targeted audience and other appropriate groups should be asked to "participate in the final selection of the specific need or needs to be addressed." (Wolf 1983c, pp. 2-3) In other words, the discussion, the analysis of these two lists of prioritized needs should extend beyond this document, and perhaps this section of the study should be viewed as a point of departure for practical applications of this project's data base. The next section of this Chapter applies a statistical analysis to the question of how much agreement/disagreement is indicated by the experts' and teachers' rankings of the needs statement.

Testing The First Null Hypothesis: Comparing the Teachers' and Experts' Perceptions

The previous section of this Chapter offered a review and description of the ranked need statements for the two groups--the energy experts and the industrial arts teachers. The discussion was focused on the top thirty ranked items. Despite some topics of disagreement, the experts and teachers appeared to have many more areas of shared perceptions. The basic question was how do the primary knowledge users (industrial arts teachers) perceive the body of renewable energy knowledge they need to acquire for teaching purposes as compared to how the knowledge producers (renewable energy experts) perceive the same question.

In order to examine this comparison statistically, the following null hypothesis was stated: H_1 There will be no relationship between the perceived needs of industrial arts teachers and the perceived needs of renewable energy experts pertaining to the teachers' need for knowledge to teach renewable energy education. This hypothesis was tested by calculating a rank order correlation coefficient, specifically Spearman's coefficient of rank correlation $\underline{p}$ (the Greek letter rho). According to Ferguson (1981), the measure of disarray $\sum d^2$ is used in the definition of Spearman's coefficient of rank correlation, and the calculation of $\underline{p}$ is relatively straightforward.

In this study, the two groups of experts and teachers scored or weighted 493 needs statements. Using these responses and a simple computer program for an Apple IIe, the researcher calculated the rank orders for two 493-item lists of need statements--one based on the experts' responses and one for the teachers' responses. These two prioritized lists were then transferred from the Apple IIe diskette to a storage file in Keene State College's Digital/VAX computer system. Through the application of an SPSS-X program, the differences between the paired ranks for each of the 493 needs statements were calculated.

These differences were squared and summed to obtain $\sum d^2$. The following formula was then applied to determine p.

$$\underline{p} = 1 - \frac{2\sum d^2}{\sum d^2_{max}}$$

Spearman's coefficient of rank correlation p is "a statistic defined in such a way as to take a value of +1 when the paired ranks are in the same order, a value of -1 when the paired ranks are in the reverse order, a value of 0 when the ranks are arranged at random with respect to each other." (Ferguson 1981, pp. 381-2) Using the SPSS-X program, p was calculated to be .6269 for the 493 paired rankings. To double-check the data, all the tied ranks were replaced by average ranks. In other words, if two items shared the same weighted score and were matched with the ranks 10 and 11, the two tied ranks were replaced by the average rank of 10.5. The recalculation of Spearman's p using tied ranks resulted in p = .6273. This recalculation based on average ranks accomplished two objectives. First, it established the accuracy of the first run of the SPSS program. Secondly, the development of average rank scores provided a more pristine set of data for calculating congruency scores for industrial arts teachers and thus for testing the second null hypothesis. Photocopies of the two original SPSS-X printouts can be found in Appendix J.

Testing the significance of Spearman's p involves an understanding of the role of the quantity N, where N equals the number of pairs of correlation (Ferguson 1981). For this study's rank correlation, N equals 493 or the number of items that were ranked by both groups of experts and teachers. Tables are often included in statistical texts that provide critical values of $\underline{p}$ at different values of N. As N increases in size, the sampling distribution of $\underline{p}$ approaches the normal form and this normalization is reflected by the tables. In other words, for small values of N, values of $\underline{p}$ of a very substantial size must be obtained before the correlation indicates a signification association in either direction. For example, at N = 10, $\underline{p}$ must be equal to or greater than .564 in order to indicate a significant association in a positive direction at the five percent level.

For an N = 10 or greater, Ferguson (1981) indicates that the significance of $\underline{p}$ may be tested using a t given by the following formula:

$$t = \underline{p}\sqrt{\frac{N - 2}{1 - \underline{p}^2}}$$

Using this formula, t = 17.8485. The 491 degrees of freedom for this statistic t poses a minor problem of interpretation. A standard table of the critical values of t in Ferguson's text (1981, p. 524) lists df = 120 and df = ∞. However, in order for the observed $\underline{p}$ (.6273) to be significant at the .001 level for a two-tailed test and the .0005 level for a one-tailed test, t must have a value of 3.373 (for df = 120) and 3.291 (for df = ∞). Therefore, despite the fact that df = 491 falls between values in the standard table, the observed value of t, .6273, is significant and $\underline{p}$ is significantly different from 0. In conclusion, the first null hypothesis was rejected, and the positive value of $\underline{p}$ provided evidence that the two groups--experts and teachers--share many perceptions concerning industrial arts teachers' need for knowledge to teach renewable energy education.

Congruency: Teachers Who Share the Experts' Perceptions

The next major step of the data analysis was designed to determine the degree to which individual industrial arts teachers share similar opinions of teachers' needs for knowledge to teach renewable energy with the experts' group. The previous data analysis compared the teachers' and experts' rank order of the 493 needs; that comparison was between two groups. In this analysis, the comparison was between the expert group and each individual industrial arts teacher. The analytical design was straightforward: the rank order for each of the 493 need statements as provided by a single teacher was correlated with the rank order for each need statement as generated by the group of experts. This procedure was repeated for each teacher, and the resultant correlations were used as indices of congruency. In other words, these indices of congruency described how closely each teacher shared the perceptions of the experts. The measurement of congruency was critical for the testing of the study's last two null hypotheses; congruency was the dependent variable in the multiple stepwise regression analysis, and the concept of congruency was used to identify potential teacher-trainers.

Although the analytical design for determining indices of congruency was straightforward, the procedures required to run the data as an SPSS-X calculation for rank order correlation required a time-consuming data entry process and the development of several specialized computer programs. First, each teacher's set of responses to the Renewable Energy Survey (RES Form A or B) was coded and recorded on Apple IIe diskettes. This data was then transferred to the VAX Computer at Keene State College. Next a special program was written to make several calculations for each teacher's set of responses: 1) the program directed the computer to count the number of circles, checks, and blanks (values of 2, 1, 0 respectively) for each respondent; 2) the program directed the computer to calculate the average rank scores for each of the 245/248 items on RES Form A or B.

Once each teacher's set of average rank scores was calculated, two sets of eight special computer programs (eight programs for each RES Form A and Form B) were devised to organize this data into a format compatible with the SPSS-X package. Each of the manipulations of the data required manual checks of the original RES Forms A and B to ensure 100 percent accuracy. Two trial runs of the special programs using data for two respondents for each RES Form A and B were run and manually checked to doublecheck the programs. To give the reader a sense of the complexity of this programming effort, the SPSS-X program for calculating 200 rank order correlation scores required 268.17 seconds or almost four and one half minutes of CPU (Central Process Unit) time. For accounting purposes at Keene State College and for billing purposes at other educational institutions, one minute of CPU time is valued at approximately $300 per minute. The final SPSS-X run to calculate the correlation scores, if charged out, would have amounted to $1350.00. The organization of the raw data into a SPSS-X compatible format required another four minutes of CPU time.

Rank order correlations then were calculated for 200 teachers. Although 217 teachers had responded to the RES, seventeen of these teachers had failed to return the Teacher Data Sheets, and their correlation scores could not be analyzed with regard to demographic data.

The rank order correlations, for the purposes of this study, were labeled as indices of congruency, or the degree to which individual teachers agreed or disagreed with the energy experts. The theoretical range of a rank order correlation is from -1 to +1 where -1 represents a perfect negative relationship, +1 represents a perfect positive relationship, and 0 represents a perfectly random relationship. The anticipated range of scores for this comparison of an individual's rank order and the expert group's rank order of the items in RES Form A or B was considerably less than -1 to +1.

Although the expert group's rankings of the RES Form A and B involved a small number of average ranks, the individual teachers were limited to three categories of ranks: circles were used to indicate the twenty-five (approximately) most important need statements; checks represented knowledge teachers needed to know or important items; the absence of checks indicated need statements of little or no importance. In other words, individual teachers' rankings consisted of three sets of tied ranks that were calculated as average ranks. The value of these indices of congruency or correlation scores was not established by the calculation of a single correlation, rather the value was determined by the comparison of one teacher's score or indice of congruency to the scores of the other 199 teachers.

The following Figure 5 Frequency Histogram: Congruency with Experts is a word-processed reproduction of a histogram generated by a SPSS-X program. This histogram provided an excellent analysis of the congruency scores.

```
COUNT  MIDPOINT  ONE SYMBOL EQUALS APPROXIMATELY .60 OCCURRENCES

  1     -.050    **
  0     -.025
  5     0.0      ********
  2      .025    ***
  7      .050    ************
  9      .075    ***************
  9      .100    ***************
  9      .125    ***************
 10      .150    *****************
 11      .175    ******************
 11      .200    ******************
 19      .225    ********************************
 15      .250    *************************
 27      .275    *********************************************
 16      .300    ***************************
 15      .325    *************************
 12      .350    ********************
  7      .375    ************
  7      .400    ************
  6      .425    **********
  2      .450    ***

                 I....+....I....+....I....+....I....+....I....+....I
                 0         6         12        18        24        30

                           HISTOGRAM FREQUENCY

   VALID CASES    200     MISSING CASES    0
```

Figure 5: Frequency Histogram: Congruency with Experts

The SPSS-X program was also used to calculate the following set of basic statistical characteristics of this frequency distribution of congruency scores. Table 19 is a reproduction of the SPSS-X printout.

Table 19

Basic Distribution Statistics: Congruency with Experts

MEAN	.234	STD ERR	.008	MEDIAN	.252
MODE	.095	STD DEV	.108	VARIANCE	.012
KURTOSIS	-.517	SKEWNESS	-.318	RANGE	.477
MINIMUM	-.039	MAXIMUM	.438	SUM	46.73%
VALID CASES	200	MISSING CASES	0		

Using any of a variety of cut-off points indicated by the frequency distribution, teachers with "high" congruency scores could be labeled as potential teacher-trainers. Teachers who were nominated by peers as potential in-service instructors (Teacher Data Sheet) and who also had high congruency scores would form an even stronger group of potential teacher-trainers. The next sections of this chapter will investigate the relationship between teachers congruency scores and demographic data, including peer nominations.

Testing The Second Null Hypothesis: Teacher Demographics and Congruency

The testing of the second null hypothesis resulted in the findings presented in the following section. The second null hypothesis reads thusly:

> There will be no relationship between selected demographic variables (professional development, teaching experience, etc.) and the indices of congruency.

This null hypothesis was tested for significance by using a stepwise multiple regression technique. This analysis technique describes the relationships of single and various combinations of independent variables (selected demographic factors) to the criterion or dependent variable (measures of congruency) by combining the procedures of correlation and regression. The list of selected demographic factors that were taken from the industrial arts teachers' responses on the Teacher Data Sheet are presented in Appendix K.

The data from the responses to Teacher Data Sheets was coded and entered using a special data-entry program for an Apple IIe. The data was then transferred to files in the Keene State College VAX computer system. Data from 226 responses was logged in, but only the data from the 200 respondents who filled out both the Teacher Data Sheet and the RES Form A or B was utilized in this stepwise multiple regression technique. The response rate for this step of the study then was 65%. As was done with the checking of the congruency data base, printouts of filed and sorted demographic data were tested against the original responses to the Teacher Data Sheets. Secondly, a standard set of distribution statistics were run for each of the 126 data entry points. A summary of this data in the form of frequencies is listed in Appendix K. The demographic data demonstrated that the 126 independent variables were properly entered in the SPSS-X program that runs the series of stepwise multiple regression calculations.

The SPSS-X program offers "forward stepwise inclusion" in which the computer enters variables in single steps from best to worst. In other words, the variable that explains the greatest amount of variance in the criterion or dependent variable is entered first, and the computer calculates a selected set of statistics that describes the overall accuracy of the prediction equation. Next, the computer determines a second variable of the remaining set of variables that explains the greatest amount of variance in conjunction with the first variable. The computer then calculates the selected set of statistics for this second variable. The process is repeated as subsequent variables (those that explain the greatest amount of variance unexplained by the variables already in the equation) are entered into the multiple stepwise regression equation at each step. (Nie et al. 1975)

The SPSS-X program not only provides the set of statistics for each selected variable, but it also keeps a running list of another set of descriptive statistics for a) the variables in the equation, and for b) the variables not in the equation. Additionally, the computer only enters variables in single steps from best to worst predictor that meet specific statistical criteria. The SPSS-X stepwise regression program involves three cut-off points. The best set of predictor variables must:

1) Contribute at least one percent to the explanation of the variance in the dependent variable (congruency).
2) Cause the overall F-ratio to remain significant when they are entered into the regression equation.
3) Cause a decrease in the standard error of estimate.

For the purposes of this study, Figure 6 describes a set of statistics that test the above null hypothesis. Only ten of the 126 variables met the established criteria. The statistic R^2 offers the most straightforward interpretation. Figure 6 shows that the best predictor is variable 007, the fact that an industrial arts teacher teaches in a combination junior-senior high school. This best predictor explained just over four percent of the variance in the dependent variable, congruency. The second best predictor was variable 076, the fact that a teacher holds a teaching certificate in a category other than industrial arts. This predictor, operating alone explains over three percent of the variance (increase in R), and in combination with variable 007, explains 7.5 percent of the variance in congruency. The total explained variance for the dependent variable congruency, based upon the ten best predictor variables, was twenty-five percent.

Although many of the remaining 116 variables did in fact cause a decrease in the standard error of estimate (SEE) and also did cause the overall F-ratio to remain significant, these variables failed to contribute at least one percent to the explanation of the variance. Therefore, the second null hypothesis was rejected only for the ten best predictor variables (007, 076, 148, 114, 016, 108, 054, 051, 099, and 040).

Multiple regression is a general statistical tool for analyzing the relationship between a dependent variable and a set of independent or predictor variables. Used as a descriptive tool in this study, the stepwise multiple regression evaluated the contribution of specific

Figure 6

A STEPWISE MULTIPLE REGRESSION ANALYSIS BETWEEN INDEPENDENT VARIABLES AND THE DEPENDENT VARIABLE - CONGRUENCY

Variable Number	Description of Independent Variable	Frequency of Affirmative Responses	Multiple R	R Square	Increase in R	SEE	F-Value	Sig.
007	Junior-Senior High	51	.20761	.04310	.04310	.10599	8.91847	(.0032)
076	Teaching certificate(s) other than industrial arts	38	.27487	.07555	.03245	.10444	8.05032	.01 (.0004)
148	Other subjects taught as primary area of responsibility - Jr. High	14	.31838	.10137	.02582	.10324	7.36981	(.0001)
114	Membership - NHIEA	59	.36039	.12988	.02851	.10185	7.27659	(.0000)
016	Woodworking taught as primary area of responsibility - Sr. High	57	.39464	.15574	.02586	.10058	7.15735	(.0000)
108	Regularly attend AVA functions	3	.41965	.17611	.02037	.09962	6.87564	(.0000)
054	Welding taught as secondary area of responsibility - Sr. High	4	.44374	.19691	.02080	.09861	6.72508	(.0000)
051	Welding taught as primary area of responsibility - Jr. High	6	.46571	.21688	.01997	.09763	6.61209	(.0000)
099	Membership - AIAA	43	.48730	.23747	.02059	.09659	6.57436	(.0000)
040	Plastics taught as primary area of responsibility - Sr. High	4	.49708	.24709	.00962	.09598	6.92821	0.0

variables and sets of variables while controlling confounding factors and establishing prediction accuracy. This analysis also functioned as an inferential tool by which the second null hypothesis was tested. Lastly, this regression analysis provided information that suported the results of the needs analysis methodology (NAM).

A review of the identification and prioritization of need statements indicated that, in the broadest sense, renewable energy technology as a knowledge or subject content did not fit neatly into the State of New Hampshire's cluster area in Energy and Power. The ten best predictor variables in explaining congruency (the degree to which an individual agreed with the energy experts' opinion) supported this concept that renewable energy technology has not been allied with energy and power programs. The best predictor was the fact that a teacher works in a combination junior-senior high. In New Hampshire, such combination schools are found in smaller, more rural school districts, and industrial arts teachers are more likely to have a combination of junior-senior high teaching responsibilities that cover a broader range of content areas. Membership and participation in professional organizations (114, membership - NHIEA; 108, regularly attend AVA functions; 099, membership - AIAA) were logical predictor variables; teachers active in professional organizations benefit from access to new educational and technological information. Further evidence of the orientation of renewable energy technology in all three cluster areas (Energy and Power, Materials and Process Technology and Visual Communication Technology) was provided by the predictor variables that describe teachers' teaching reponsibilities (016 Woodworking, 054 Welding, 051 Welding, and 040 Plastics). Lastly, the scientific, quantitative and conceptual orientation of the experts' vision of renewable energy education was reflected by variables 076 (teaching certificate(s) other than industrial arts) and 148 (other subjects taught as a primary area of responsibility).

Conversely, if Energy and Power was the targeted cluster area for the inclusion of renewable energy technologies, it would be logical to anticipate that teachers in that cluster area would be more inclined to share the energy experts' opinion of what teachers need to know in order to teach renewable energy technology. The following Table 20 indicates that variables related to teaching power and energy courses failed to explain more than one percent of the dependent variable, congruency. These variables were entered in the stepwise regression between steps 48 and 86 of the 126 step regression.

Table 20

Variables Related to Power and Energy Teaching Responsibilities

Position in Stepwise Regression	Variable Number	Frequency of Affirmative Responses	Description of Variable
68	031	8	Power and energy as primary area of responsibility - Jr. High
82	032	21	Power and energy as primary area of responsibility - Sr. High
48	035	19	Small engines/automechanics as primary area of responsibility - Jr. High

Position in Stepwise Regression	Variable Number	Frequency of Affirmative Responses	Description of Variable
64	036	38	Small engines/automechanics as primary area of responsibility - Sr. High
57	023	13	Electricity/electronics as primary area

Somewhat of a surprise was the fact that industrial arts teachers' involvement or interest in renewable energy workshops/courses did not have a significant predictive value:

Table 21

Variables Related to Professional Development

Position in Stepwise Regression	Variable Number	Frequency of Responses	Description of Variable
76	097	38 (yes)	College-level course that included renewable energy topics
38	098	87 (yes)	In-service course/workshop that included renewable energy topics
66	140	155 (yes)	Would attend an in-service workshop in renewable energy topics

Possible explanations of this factor are that 1) recognized renewable energy experts did not make up the pool of course/workshop instructors and that 2) these presentations may have offered "misinformation" as much of the general public energy education efforts have done in the past (refer to Chapter II, Part I Energy Education). For instance, the University of New Hampshire's summer program in energy education (1981, 1982, 1983) has attracted industrial arts teachers and has presented nuclear power (the Seabrook, NH, generating station for instance) as an "alternative energy" source.

Finally, a review of the variables that were entered in the regression analysis on steps eleven through thirty supports the theory that teachers' congruency scores were best predicted by involvement in professional/energy organizations, by teaching responsibilities outside of traditional energy and power craft areas, and by involvement in math and science courses.

Table 22

Stepwise Multiple Regression Analysis: Predictor Variables Entered Steps 11-30

Variable Number	Frequency of Responses	Description of Variable
112	1	NEIAA - formal presentations
070	1	Administrative role as secondary area of responsibility - Sr. High
092	5	Master's + 30 hours
042	1	Plastics as secondary area of responsibility - Sr. High
021	3	Drafting as secondary area of responsibility - Jr. High

Variable Number	Frequency of Responses	Description of Variable
057	2	Math as secondary area of responsibility - Jr. High
059	2	Science as primary area of responsibility - Jr. High
129	2	Membership - NESEA
026	2	Electricity/electronics as secondary area of responsibility - Sr. High
043	2	Machine shop as primary area of responsibility - Jr. High
062	1	Science as secondary area of responsibility - Sr. High
041	2	Plastics as secondary area of responsibility - Jr. High
121	1	NHVEA - committee work
122	1	NHVEA - formal presentations
050	1	Graphic arts as secondary area of responsibility - Sr. High
060	1	Science as primary area of responsibility - Sr. High
009	4	Private school
146	148 (yes)	Would like to receive a summary of the results of this study
022	9	Drafting as secondary area of responsibility - Sr. High
124	5	Membership - NHSEA
065	1	Other subjects listed as secondary area of responsibility - Jr. High

In conclusion, the testing of the second null hypothesis provided statistical evidence to measure the best predictor variables of congruency from the large number of demographic data variables. The results of the stepwise multiple regression also supported the concept that the renewable energy experts' vision of what industrial arts teachers need to know in order to teach renewable energy education is broader in scope than the specific, technical knowledge base associated with traditional energy and power programs.

Testing The Third Null Hypothesis: Influential Status and Congruency

The last major objective of this study was to identify a group of New Hampshire industrial arts teachers who should be screened at a later date as renewable energy education teacher-trainer candidates. This objective was developed to satisfy specific recommendations outlined in the Wolf-Welsh Linkage Methodology (WWLM). Step VI, Part B suggests that an uncomplicated sociemetric survey technique be used to identify the "influentials" and the "isolates" of the targeted audience (Wolf, 1983c). Influential teachers would then be screened to determine who in that group would be trained to instruct the State's industrial arts teachers in renewable energy technologies.

As a supplement to this nomination process, a third null hypothesis was proposed to determine the relationships between teachers' status as influential and their congruency with the energy experts. The results of the survey will be described first, and then the results of the hypothesis testing will be presented.

The identification of influential/isolate teachers for this study was based on a brief, sociometric survey question that appeared as the next to last item on the Teacher Data Sheet (see Appendix G). The industrial arts teachers were asked to name five colleagues from whom they would prefer to receive in-service training in renewable energy education, assuming that the nominated teachers would have received appropriate technical updating from energy experts.

One hundred people were nominated, sixty-seven of whom were listed as industrial arts teachers in the 1983-1984 New Hampshire Industrial Education Teacher Directory. The other thirty-three nominees included members of Keene State College's Industrial Education and Technology Department, vocational instructors and administrators, and renewable energy experts. The top thirteen nominees from the industrial arts teacher group are listed in Table 23, and the entire list of nominees, nominators and comments compiled from the Teacher Data Sheets can be found in Appendix H.

Table 23

Nominations for Influential Teachers

ID Number	Nominating Teacher
198	008, 203, 027, 260, 200
144	140, 142, 145, 146
146	140, 142, 145
128	258, 127

ID Number	Nominating Teacher
186	185, 319
145	142, 146
140	145, 146
008	249, 107
197	200, 203
026	027, 025
261	027, 260
024	027, 025
313	311, 312

The results of the influential/isolate teacher identification process are open to two incompatible interpretations. In one interpretation, the low number of responses to the nomination item can be viewed as evidence of a failure of the survey instrument. The data is insufficient from which to draw conclusions. However, from another perspective, the lack of nominations can be interpreted as an indicator of the isolated position of the majority of the State's industrial arts teachers. In other words, the most important result of this survey item can be attributed to the fact that not many nominations were offered.

The actual results of the influential teacher identification process were straightforward. Despite the fact that sixty-seven industrial arts teachers were nominated, the total number of teachers who actually nominated peers was just forty-two. An additional number of respondents did make comments: two suggested that only energy experts should direct workshops; nine teachers indicated that any number of knowledgeable energy experts or industrial arts teachers could do the job; eight teachers claimed that they could not nominate a colleague; four teachers argued that no teachers could be proficient at teaching renewable energy education; and one teacher refused to answer the question because he felt that appropriate in-service workshops would never be offered due to a lack of funding. Therefore, only sixty-six of the 226 respondents (29%) answered the sociometric question (see Appendix H).

There are several possible explanations for this apparent lack of interest in the question. By the end of the Teacher Data Sheet, respondents may have "burned out." However, a check of all the surveys indicated that with very few exceptions, the respondents had answered the items bracketing the nomination request. Although burn-out must be recognized as a contributing factor, there are several additional arguments for a lack of teachers' knowledge about their peers' abilities.

Of the top thirteen nominations, nine teachers (198, 144, 146, 145, 140, 197, 026, 024, 313) were nominated only by the teachers in their own school (refer to Table 23). As indicated earlier in this study (the selection of teacher-definers), the New Hampshire State Consultant for Industrial Arts had identified only eight or so industrial arts teachers who had had any significant experience with energy education. Also, due to funding limitations, in-service workshops for industrial arts teachers during the previous decade were limited in number. The rural nature of the State, combined with limited local and state budgets may tend to isolate further the State's industrial arts teachers. Lastly, the State's leading professional organization, the New Hampshire Industrial Education Association (NHIEA) had attained only modest membership figures in the previous four years; membership ranged from twenty to fifty teachers during this time. Confirming this reluctance to participate in professional organizations, the results of this study's demographic factors indicated that fifty-nine of 200 respondents claimed membership in the NHIEA (see Appendix K).

Based upon these factors that describe teacher isolation, it would be logical to interpret the teachers' sporadic attempts to nominate influential colleagues as the product of a lack of familiarity with the members of the State's industrial arts teaching profession. The majority of the respondents simply did not feel sufficiently knowledgeable about their colleagues in the State to make nominations. Of the sixty-six teachers responding to the survey item, only forty-two wrote down the names of individuals. Analysis of the responses of these forty-two persons provided further evidence that teachers did not nominate colleagues representing the classroom instructors throughout the State. See Table 24 for this breakdown of nominations.

Table 24

Analysis of Nominations for Influential Teachers

Number of Responses	Description of Nominations
6	5 nominations, all NH IA teachers
7	5 nominations, including colleagues who were not NH IA teachers
9	less than 5 nominations, all NH IA teachers
12	less than 5 nominations, all colleagues who were not NH IA teachers
8	less than 5 nominations, all colleagues who were not NH IA teachers
42	Total number of nominators

For the purposes of this study and the WWLM, it is sufficient to note the industrial arts teachers who should be considered "influential". Only thirteen teachers received more than one nomination. These individuals should be interviewed at a later date to determine their interest in renewable energy education and their desire to instruct their industrial arts colleagues in renewable energy techologies. The other function of the nomination process was to identify "the isolates" in this profession. It appears that the vast majority of the State's New Hampshire industrial arts classroom teachers are isolated. Only sixty-seven of the 317 teachers were even nominated once. Lastly, Table 23 and the list of all nominations (see

Appendix H) indicate the parochial nature of the nominations. Respondents overwhelmingly nominated people working in the same building; only fourteen of the sixty-seven nominees were nominated by teachers outside their school building.

The last step of the data analysis process was the testing of the third null hypothesis:

> There will be no relationship between the rank order of influential status of the industrial arts teachers and their congruency with renewable energy experts.

This null hypothesis was tested for significance by implementing the most commonly used measure of correlation, the Pearson product-moment correlation coefficient (Ferguson 1981). This correlation coefficient, r, and other measures of correlation are defined by common convention to assume values ranging from -1 to +1. The value -1 represents a perfect negative relation; the value +1 describes a perfect positive relation; the value of 0 represents a random relation.

The calculation of r involved measurements of two variables (X and Y), each industrial arts teacher's rank order of influential status and congruency score. X and Y were treated as paired observations. The following formula was used for computational purposes (Nie, p. 280):

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

where x and y are deviations from the means $\overline{X}$ and $\overline{Y}$ respectively

The data for peer nominations from the Teacher Data Sheets and the congruency scores of 200 teachers were coded and run on the SPSS-X Pearson correlation program using the Keene State College VAX computer. Only the data for 200 respondents who filled out both the Teacher Data Sheet and Survey Form A or B could be used in the SPSS-X calculations.

The Pearson correlation r was calculated as r = .0374 at the significance level of S = .299. Although the Pearson correlation r = .0374 suggests a random relation, the test for significance indicates that the variance cannot be considered statistically significant. A photocopy of the original SPSS-X printout can be found in Appendix J.

The significance of r can be further tested by calculating a t score based on the following formula (Ferguson 1981, p. 195).

$$t = r\sqrt{\frac{N - 2}{1 - r^2}}$$

where N equals the number of paired observations

Using this formula, t = .5266. A standard table of critical values of t in Ferguson's text (1981, p. 524) shows that the calculated t = .5266 fails to meet the value 1.980 required for a level of significance at the .05 level for a two-tailed test. Therefore, there is no statistical evidence at the .05 level of significance to warrant rejecting the third null hypothesis.

In conclusion, the identification of influential teachers did produce a sizeable pool of teachers to screen as potential teacher-trainers. The value of the test for the third null hypothesis was the confirmation of the concept that a teacher's nomination does <u>not</u> automatically qualify that person as a teacher-trainer in renewable energy education. A review of the "Nominations for Influential Teachers" (see Appendix H) establishes the practical appliation of the congruency scores. If four teachers from the same school district were nominated, the decision to target one or two of those teachers as potential teacher-trainers would be aided by a comparison of their congruency scores. For instance, teachers 140, 144, 145, and 146 are all from the same school and all four were nominated. Their congruency scores were .4358, .2848, .1372, .0818 respectively. It would be logical to target teachers 140 and 144 based upon the combination of their influential status and congruency with the energy experts.

Another application of this process applies to teachers who work in relative isolation as the only industrial arts teacher in a rural school. If resources were to limit participation in a teacher-trainer preparation program, it would be logical to focus on teachers from larger industrial arts departments as opposed to teachers who work alone. Congruency scores would be an excellent criteria for targeting a limited number of those teachers who work alone. For instance, teachers 008 and 249 work in one-person departments, but both scored well--.3874 and .4047. Both are also active in the NHIEA, and the combination of congruency scores and influential status would outweigh the potential problems of information dissemination. The last example would involve targeting teachers who were not nominated by peers, but who had a high degree of congruency with the energy experts. Teacher 138 is an excellent example; he scored .4212 but was not nominated most likely because he works in a two-person department in a rural high school. According to the State's Industrial Arts Consultant, this teacher offers the most innovative power and energy program in the state, but he is relatively unknown to his industrial arts colleagues. There are probably more renewable energy-oriented teachers who work in relative obscurity. Follow-up studies of those teachers not nominated by peers but scoring well in congruency would assist in identifying the best possible teacher-trainers in renewable energy education.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Overview of the Chapter

This Chapter includes 1) a summary of the objectives, research methods, and results of the study, 2) conclusions based upon observations and interpretations of the data, 3) immediate contributions of the study to the profession, 4) long-range implications of the study's findings, and 5) recommendations for further study. Beyond the formal objectives, design, data analysis, and results of this study, several benefits derived from the study should be noted. Some of these benefits should contribute directly to the challenge of promoting renewable energy technology in the field of industrial arts in New Hampshire. This major focus of this Chapter is to summarize the projected impact of the study's data and findings on the subsequent steps outlined in the Wolf-Welsh Linkage Methodology (WWLM) and the Needs Analysis Methodology (NAM) that affect the industrial arts teacher education program at Keene State College.

Summary

Purpose of the Study

This study was designed to initiate the process of bringing the knowledge of renewable energy education into the field of industrial arts education in the state of New Hampshire. The four major objectives of the study were to provide the following information to the State's leaders in industrial arts education:

1) A broad-based perspective of national energy issues that would assess the appropriateness of renewable energy technology as a subject/content area in industrial arts education.

2) The introduction of a knowledge production/knowledge utilization model that would outline the "blueprint" for integrating renewable energy education into the State's industrial arts programs--the Wolf-Welsh Linkage Methodology (WWLM).

3) The generation of a list of industrial arts teachers' needs for knowledge to teach renewable energy education and the prioritization of that list by two groups (industrial arts teachers and renewable energy experts) as outlined by the procedures set forth in the Needs Analysis Methodology (NAM).

4) The analysis of industrial arts teachers' demographic data and peer nominations for the purposes of identifying a core of potential teacher-trainers.

Methodology

Based on these four major objectives, the procedural requirements of the following steps of the WWLM (Wolf 1984) were identified as appropriate for this study: "Step I. Attributes of Persons Apt to Use the Linkage Methodology Effectively", sections of "Step II. Identification of a Targeted Audience's Need to Modify Some Aspect or Aspects of Professional Practice", and sections of "Part VI. Determination of Demographic Characteristics and Certain Attitudes of the Targeted Audience." Step I. was addressed in Chapter II. The balance of the WWLM requirements were met by implementing a research design based largely on the Needs Analysis Methodology (Coffing and Hutchinson 1974). Three other components of this research design complemented the NAM: 1) sampling, 2) demographic data, and 3) statistical procedures. The NAM outlined a standardized, operationalized set of procedures for providing a list of identified and prioritized needs of industrial arts teachers for knowledge to teach renewable energy education as perceived by two groups--the State's industrial arts teachers and renewable energy experts. These four components all contributed data used in the testing of three null hypotheses.

Results

The results of the study were based on a series of survey responses that assisted in the identification of a population of renewable energy experts, the identification and prioritization of 493 needs statements, the nomination of sixty-seven "influential" teachers, and the demographic data for 226 industrial arts teachers. In addition to the acquisition of these data for decision-making, the study also involved a variety of data analysis procedures to test the three null hypothesis. The following list represents a synopsis of these data-gathering efforts and the data analysis:

1) The population of industrial arts teachers consisted of 309 teachers employed as industrial arts teachers (grades 5 through 12) in the State of New Hampshire.

2) The population of New Hampshire-oriented renewable energy experts was identified by a three-step process involving four nomination criteria. Ninety-six individuals from a master list of 344 nominees were identified more than four times by colleagues in a survey process that had a 91% response rate.

3) Responding to a stimulus question, thirty-one definers (sixteen experts and fifteen teachers) produced a list of approximately 1100 discrete need statements (100% response rate).

4) Working from the definers' responses, the researcher sorted and assembled a list of 493 discrete statements within an organizational framework and presented this sorted list as the Renewable Energy Survey Form A and B.

5) Eighty-five experts answered the survey (92% response rate); 217 teachers responded to the survey (70% response rate); 226 teachers filled out the Teacher Data Sheet (73% response rate).

6) Based on the experts' and teachers' responses to the survey, two lists of 493 prioritized needs were determined for each group. A SPSS-X program was used to calculate Spearman's coefficient of rank correlation ($\underline{p}$ = .6273) for these two ranked lists. The first null hypothesis (H_1 There will be no relationship between the perceived needs of industrial arts teachers and the perceived needs of renewable energy experts pertaining to the teachers' need for knowledge to teach renewable energy education) was rejected.

7) The extent of this shared perception by the experts' and teachers' groups was further analyzed by a discussion of the observed areas of agreement and disagreement within the eight categories of the prioritized list of need statements.

8) The degreee to which each individual industrial art teacher shared opinions (of the teachers' needs for knowledge to teach renewable energy education) with the expert group was calculated as a numerical quantity, as a rank order correlation. These "indices of congruency" for 200 teachers were used as the dependent variables in testing two null hypotheses.

9) The second null hypotheses (H_2 There will be no relationship between selected demographic variables and the indices of congruency) was rejected for only ten of the 126 demographic variables based upon calculations provided by a SPSS-X stepwise multiple regression program.

10) There was no statistical evidence to warrant rejection of the third null hypotheses (H_3 There will be no relationship between the rank order of influential status of the industrial arts teachers and their congruency with renewable energy experts) based upon a SPSS-X Pearson coefficient calculation. Sixty-seven teachers were nominated by their peers.

11) The group of sixty-seven nominated teachers and the group of teachers who shared the experts' perceptions (high congruency scores) formed a well-defined pool of potential teacher-trainers.

Conclusions

Although the industrial arts teachers and the renewable energy experts share many perceptions of the knowledge teachers need to teach renewable energy education, each group stressed different knowledge areas. The experts consistently ranked high those need statements stressing the conceptual foundations, economic justifications, and the scientific and quantitative basics of renewable energy technology. In terms of technical applications of energy conservation and renewable energy, the experts specifically identified areas in residential/ commercial building design and construction. The teachers, on the other hand, focused on knowledge of wood-burning technology, educational delivery/strategies, and the more popular "alternative energy" sources such as windpower, hydropower, photovoltaics, and biomass.

Despite these differences of opinion, the most emphatic contribution of the identification/prioritization process was the experts' and teachers' perception that residential/commercial building design, retrofitting, and construction is the single most important practical technical area for the application of renewable energy technology. This shared perception appears to contradict the decision to place energy conservation and alternative energy in the Energy and Power cluster in the State of New Hampshire's Secondary School Standards. Based on this study's results, renewable energy education appears as a subject content appropriate to all three cluster areas--Materials and Process Technology (building construction, woodworking, metals), Visual Communication (architectural drafting), as well as Energy and

Power (electricity, electronics, alternative energy, and energy conservation). Also, comprehensive or general labs appear to be appropriate settings for renewable energy-oriented courses. On the other hand, if the decision was made to incorporate this study's interpretation of renewable energy technology into the Energy and Power cluster, then the content of the traditional courses in this cluster would need to be greatly modified, or new courses would need to be designed.

In terms of the WWLM's blueprint for educational change, the above interpretation of the results can be considered as editorial or rhetorical; the practical application of this study's results is outlined in the WWLM (Wolf 1984) as "Step II. Identification of a Targeted Audience's Need to Modify Some Aspect or Aspects of Professional Practice." Specifically, the researcher has made commitments to disseminate the study's findings: 1) a summary of the results of this study will be sent to the 148 industrial arts teachers who requested this report (Teacher Data Sheet); 2) a similar report will be sent to seventy-nine experts (Expert Data Sheet); 3) a minimum of two presentations of these findings (as teacher in-service programs, Spring 1985) have been scheduled by the State Consultant for Industrial Arts and the President of the NHIEA; 4) dozens of requests for summaries (written reports or personal presentations) have been received from extension services, State Department of Education sections, two-year and four-year colleges, vocational education schools, educational and professional organizations (NHVEA, NESEA, NHAVA, Audubon Society) throughout the northern New England region.

Of these proposed dissemination efforts, this researcher's contact with the State's industrial arts teachers and leaders is most important for the task of integrating renewable energy education into industrial arts programs. As mentioned in Chapter II, this study terminates at the WWLM's Step II. Subpart D. which states "Clarify who will participate in the final selection of the specific need or needs to be addressed (i.e., a committee, all involved persons, etc.)" (Wolf 1984). Additionally, this study provided relevant information about the State's teachers. Specifically, sixty-seven teachers were nominated by their colleagues as "influential"; the indices of congruency provided quantitative data reflecting the degree to which 200 teachers agree or disagree with the renewable energy experts; and the demographic data for 226 teachers can be interpreted to assist in identifying "self-renewers", "entrenchers", influentials", and "isolates". These data concerning teachers meets many of the requirements of the WWLM "Step VI. Determination of Demographic Characteristics and Certain Attitudes (Toward the Plan to Modify Some Aspect or Aspects of Professional Practice) of the targeted Audience." and "Step VII. Conceptualization and Implementation of Strategies and Tactics Intended to Incorporate Designated Practices and/or Products Within the Professional Practice of the Targeted Audience." (Wolf 1984).

In conclusion, the study met the targeted requirements of the WWLM's Steps I, II, VI, and VII, and provided the necessary data for decision-making. However, this study represents only the beginning of the task to promote educational change in the State of New Hampshire.

Contributions to the Profession

The results of this study should have an immediate impact on New Hampshire's only industrial arts teacher-training institution, Keene State College, and its Industrial Education and Technology (IET) Department. This impact is not limited to the IET Department's industrial arts teacher-training curriculum. The IET Department provides leadership for the industrial arts profession in the State and in the region, and it also directs the program for vocational education teacher-training. From its traditional role as the State's industrial arts teacher-training institution, the IET Department over the past twenty years has added an AS degree and a BSIT degree program with concentrations in drafting and design, manufacturing processes, electricity/electronics and a general option.

In terms of industrial arts teacher training, this study has effectively defined the energy experts and the State's industrial arts teachers' perceptions of what the IET Department should cover in the content areas of energy conservation and alternative energy.

Since this researcher teaches the power and energy courses in the IET IA curriculum, the project has directly provided the following additional detailed data:

1) Two 493-item prioritized lists of teachers' needs for knowledge to teach renewable energy education.
2) A mailing list of more than 400 energy expert nominees.
3) Detailed demographic data for eighty-eight renewable energy experts.

4) Numerous bibliographies, lists of resource people, institutional and educational activities, and other resource material that energy experts mailed to the researcher.

5) Content appropriate for a Power/Energy course entitled "Energy Conservation and Technology."

6) Models of advisory committees' efforts that have overseen the successful implementation of renewable energy technologies in various educational settings.

7) Content appropriate for courses in building construction (IET 275 and IET 375), architectural design (IET 223), and various courses in manufacturing processes, computer-aided design, power mechanics, electricity/electronics, general metals, and wood-working.

This study has strengthened the IET Department's data base for carrying out its leadership role in industrial arts by providing the following:

1) Updated demographic data on the State's industrial arts teachers, including names/positions of new teachers.

2) Identification of unfilled positions.

3) Data on closed-out industrial arts positions.

4) Data to support grant applications for in-service training/ workshops for the 1984-1985 and 1985-1986 school years.

5) Data to contribute to the development of the first state-wide curriculum guide, a resource book for program and curriculum designs and teaching strategies for the Energy and Power cluster.

6) Home mailing addresses and telephone numbers for recent Keene State College graduates teaching industrial arts in New Hampshire.

7) Home mailing addresses and telephone numbers for the 1983-1984 membership of the New Hampshire Industrial Education Association.

8) Identification of exemplary industrial arts/vocational education/technical programs in New England that feature renewable energy technology.

In the area of vocational teacher-training, this project's need analysis data are directly applicable to building construction programs in vocational education. In brief, vocational education teacher- candidates should be directed to appropriate IET courses, for instance, IET 265 Energy Conservation and Technology. Also, several exemplary programs in vocational building construction in the northern New England region have featured energy-efficient building projects (solar-heated and superinsulated residences, greenhouses and sun-spaces). Most of these exemplary projects relied upon strong advisory committee support, specifically the expertise of renewable energy experts.

The direction of the building trades towards more energy-efficient designs and construction practices should also affect the IET Department's courses in building construction. This project supplies a most appropriate data base for updating the IET Department's courses in building construction--whether those courses are aimed at industrial arts teacher-candidates, vocational teacher-candidates, or building construction trainees. In fact, the prioritized list of needs may have an even larger part to play in the development of the IET Department's courses in building construction.

Although the last contribution of this study came as a surprise to this researcher, its impact should be most immediate. During the Spring 1985 semester, members of the IET DEpartment will be proposing a new option in the two year AS-degree program in Industrial Technology. The new option will be Building Construction Technology. The direction of the building trades in New England has been towards more energy-efficient design and construction practices. Because woodworking and building construction are craft areas in industrial arts, and the renewable energy experts allied industrial arts programs with other hands-on programs in public schools, the energy expert-definers developed a comprehensive list of basic, practical skills and knowledge needed by industrial arts or vocational education teachers to teach energy-efficient building construction. In other words, sixty to seventy-five percent of the identified and prioritized needs of this study can be applied to vocational building trades teachers' needs for knowledge to teach energy-efficient design and construction practices.

These same three hundred to three hundred and seventy-five needs should supplement the data base required of the application process for the new AS-Building Construction Technology degree program (University System of New Hampshire review process and the internal program development review at Keene State College), the development of the program goals and objectives, and the design of course objectives, content, and teaching strategies.

Furthermore, numerous renewable energy experts have offered their assistance in putting this program in operation because because they believe tradesmen, foremen, and managers in the building construction industry must be educated in energy-efficient building practices. More than a third of the experts have offered to provide testimony to program reviewers, to support the program as advisory committee members, to give guest lectures, demonstrations, and field trips, and to teach regular semester-long courses as adjunct staff.

Based upon the impact of the formal data, informal information, and personal contacts generated by this study, the practical applications of this study will no doubt assist the IET Department in the near future to meet a variety of challenges.

Implications for New Directions

There is growing evidence that Industrial Arts programs in the Northeast region of the country have been subjected to outside pressures that have challenged the traditional goals, objectives, and mandates of this segment of general education. These pressures are described as follows:

1) Budget constraints--Proposition Two and One Half in Massachusettes; New England's reliance on local property tax base for public education; the increases in the percentage of public education

funds that support teacher salaries/benefits and other fixed costs; the public concern for balanced state government budgets.

2) Lack of qualified industrial arts teachers--the rapid drop nationally in the number of industrial arts teacher-candidates in teacher-training institutuions; the continued problem of filling industrial arts teacher positions in the State of New Hampshire and Vermont in the past few years; the turnover of industrial arts positions as teachers move into industry, private business, or vocational education.

3) National focus on renewing academic rigor in public secondary schools--the series of national-scale task force, think-tank, institutional, foundation reports on the problems in America's schools, the strengthening of academic standards for graduation in the past two years in New Hampshire and Vermont; the emergence of computer-literacy in secondary curricula.

4) Change in student clienteles--the emphasis on the construction of area vocational centers have siphoned off general education-track secondary students from industrial arts programs; revised graduation requirements have substituted higher enrollments in traditional academic courses for lower enrollments in industrial arts programs; the decade-long emphasis on mainstreaming has directed more special needs students to industrial arts programs.

These four outside pressures on industrial arts programming are described for discussion purposes only. However, budget constraints and the lack of qualified industrial arts teachers are a fact of life in New Hampshire and Vermont. The argument arises that industrial arts, as a secondary-level proram, is atrophying. The data compiled from the Teacher Data Sheets and this researcher's repeated contact with the public schools as follow-ups to the survey process supports this viewpoint. In early September, twelve industrial arts positions listed in the 1983-1984 new Hampshire Industrial Education Teacher Directory were unfilled. By November, four positions remained unfilled. More importantly, eleven positions were simply eliminated; only one school added an additional industrial arts position (see Appendix H). The majority of the eleven "lost" positions were either unfilled from the previous year or were eliminated when a teacher resigned during the 1984 summer months. Conversations with teachers and administrators during the survey follow-ups indicated that junior high school level enrollment remained strong (due to junior high school standards), but that secondary enrollments had been dropping off every year for the previous three/four years.

These formal and informal findings give added evidence to the observations that industrial arts programs are "losing ground." On the other hand, during the course of this study, the renewable enery experts, as a group, communicated their perception that industrial arts teachers are the most appropriate teacher-group to teach renewable energy education. And furthermore, the experts envisioned that industrial arts teachers should provide the basic science and math concepts of this energy technology. The experts' priority listing directly confirmed these opinions expressed by various experts during telephone conversations throughout the survey process.

The experts' personal opinions and their priority listing of teachers' needs stressed the scientific and technical content of renewable energy technology. Extrapolating on these perceptions, this researcher would argue that New Hampshire's industrial arts teachers should focus on pre-engineering type courses and/or programs for grades eleven and twelve. The programmatic model for this recommendation involves:

A) Orientation: junior high school programs remain relatively unchanged, to provide an orientation to industry and its materials, processes, and organizations.

B) Exploration: ninth and tenth grade programs offer traditional craft-oriented courses that teach basic skills as pre-vocational experiences for students entering vocational programs.

C) Implementation: eleventh and twelfth grade programs offer cluster-oriented programs in graphic communications, power and energy, and materials processing as pre-engineering or pre-technical experiences for students planning on post-secondary education.

In other words, industrial arts should co-opt the emerging national interest in computer-literacy, science and mathematics and should design upper grade programs as college-track experiences in engineering and technology. The results of this renewable energy education study support the idea that renewable energy technology is grounded in scientific and quantative concepts and that renewable energy technologies cross the boundaries of all three cluster areas. For example, energy-efficient design can be taught in graphic communications courses and can be taught utilizing computer-aided design and special software programs for passive/solar-energy/conservation design. Energy-efficient projects from passive hot water heaters, insulating shutters, wood stoves, and active solar collectors to greenhouses and sunspaces can be constructed in material processing (traditionally woods, metals, building construction craft area) shops. Energy-literacy, energy auditing, experimentation and project construction can be pursued in depth in energy and power programs.

In conclusion, this study's formal and informal data strongly support "industrial technology" as a strategy for New Hampshire's and the Northeast region's upper-level programs in industrial arts.

Recommendations for Further Study

This study represented an attempt to apply two methodologies--The Wolf-Welsh Linkage Methodology and the Needs Analysis Methodology--to the very practical challenge of promoting educational change. Certain aspects of the research design posed interesting problems that would be appropriate targets for replication:

- o How does the rank order correlation coefficient for this study ($\underline{p}$ = .6273) compare to similar calculations for other states?
- o What would be the range of congruency scores for the eighty-eight energy experts?
- o If the study were replicated in other states, would the same need statements and/or priorities emerge?
- o What relationships exist among the teachers' demographic data (126 variables for this study).

From a broader perspective, there is a need for researchers to conduct a similar WWLM/NAM approach to integrating renewable energy technology into New Hampshire's vocational education programs, and, perhaps, specifically into building trades programs. Such studies would benefit from the "lessons" of this study.

Lastly, the tradition of public education, including industrial arts education, to resist change would be mitigated by the application of practical change models and methodologies. We, in industrial arts, have only to observe the teaching of computer literacy in science and math programs to realize that our profession needs to bridge consistently and frequently the gap between knowledge producers and knowledge users.

BIBLIOGRAPHY

Akers, Lawrence, "Education and the Energy Crisis: Policies and Actions for the Department of Energy." Educational Programs Division, Department of Energy. Washington, D.C.: Development Sciences, Inc., 1980.

Andrews, Robert, Teaching Industrial Education: Principles and Practices. A revision of Teaching the Industrial Arts by Emanuel E. Ericson. Peoria, Illinois: Chas. A. Bennett Co., Inc., 1976.

AVA Energy Project, "Five Year Plan on the Role of Vocational Education in Meeting the National Energy Goals," unpublished draft, American Vocational Association Advisory Committee, 1980.

AVA Industrial Arts Committee, "A Guide to Improving Instruction in Industrial Arts." Washington, D.C.: American Vocation Association, 1968.

AVA Industrial Arts Section, "Standards of Attainment in Industrial Arts Teaching." American Vocation Association, Washington, D.C., 1934.

Bartlett, Albert, "Forgotten Fundamentals of the Energy Crisis." In Journal of Geological Education, V. 28, pp. 4-35, 1980.

Bauman, Paul, and Petrock, Edith, Energy Education: Why, What, and How? Denver, Colorado: Education Improvement Center, Education Commission of the States, 1981.

Bauchsbaum, Steven, Jobs and Energy: The Employment and Economic Impacts of Nuclear Power, Conservation, and Other Options. New York: Council on Economic Priorities, 1979.

Blackman, Michael, "Broad-Based Curriculum for Training Energy Conservation-and-Use Technicians." In Meeting Energy Workforce Needs, pp. 181-193. Silver Spring, Maryland: Information Dynamics, Inc., 1979.

Bonser, F., and Mossman L., "The Meaning and Purpose of Industrial Arts." In Selected Readings for Industrial Arts, pp. 71-79, Miller, R., and Smalley, L., (Ed.), pp. 71-79. Bloomington, Illinois: McKnight and McKnight, 1963.

Boyer, Ernest, "Energy." In Energy and Education: Teaching Alternatives, Posthuma, F. (Ed.), pp. 9-15. Washington, D.C.: National Education Association, 1978.

Brush, Hamilton, "A Needs Assessment Study To Provide Guidelines For An Inservice Elementary Teacher Program in Southeastern Massachusetts." Ed.D. dissertation, University of massachusetts at Amherst, 1976.

Brush, Hamilton, "Recent Needs Assessments in American Education." The CO-OP. University of Massachusetts, Amherst, MA, 1974.

Bupp, I.C., and Schuller, Frank, "Natural Gas: How to Slice a Shrinking Pie." In Energy Future, Stobaugh, R., and Yergin, D. (Ed.), pp. 56-78. New York: Random House, 1979.

Bupp, I.C., "The Nuclear Stalemate." In Energy Future, Stobaugh, R., and Yergin, D. (Ed.), pp. 108-135. New York: Random House, 1979.

Christensen, William, "Marketing Techniques Applied to Energy Conservation." Ph.D. dissertation (abstract), the University of North Carolina at Greensboro, 1980.

Chubb, John, "Interest Groups and the Bureaucracy: The Politics of Energy." Ph.D (abstract), University of Minnesota, 1979.

Coffing, R.T., Hodson, W.A. and Hutchinson, T.E. "A Needs Analysis Methodology for Education of the Handicapped - Version I. Final Report of Connecticut Project No. 88-404. North Haven, Connecticut: Area Cooperative Educational Services, 1973.

Coffing, Richard P. and Hutchinson, Thomas E., "A Needs Analysis Methodology: A Prescriptive Set of Rules and Procedures for Identifying and Measuring Needs." A paper prepared for the "Symposium on Methodologies Under Development" at the Annual Meeting of the A.E.R.A, Chicago, April 17, 1974.

Copa, George and Irvin, Donald, Occupational Supply and Demand: A Format with Implications for Planning Education for Work. Minneapolis, Minnesota: Minnesota Research Coordinating Unit for Vocational Education, University of Minnesota, 1979.

Doble, Richard, "The Relationship of Selected Characteristics of Industrial Arts Teachers to Change Orientation." Ph.D. dissertation, The University of Connecticut, 1977.

Dunham, Daniel, "Vocational and Adult Education - Energy and the 80's." In Meeting Energy Workforce Needs, pp. 174-180. Silver Spring, Maryland: Information Dynamics, Inc., 1979.

Edington, Everett et al, "Feasibility of Developing Post High School Technician Programs for Emerging Energy Sources in Southwestern United States." Abstract, New Mexico State University, Las Cruces, New Mexico, 1977.

Energy Education Project Advisory Committee, "Policy Recommendations for Energy Education, Grades K-12." Draft prepared for the consideration of the ECS Policy Committee. Denver: Education Commission of the States, 1979.

Energy Information Administration (Department of Energy), Statistics and Trends of Energy Supply, Demand, and Prices. Washington, D.C.: Government Printing Office, 1978.

Ertel, Kenneth, "Vocational Education and the Energy Crisis." An AVA Status Study for the American Vocational Association Energy Education Project, unpublished report, University of Massachusetts, Amherst, 1980.

Ferguson, George A., Statistical Analysis in Psychology and Education. New York: McGraw-Hill Book Company, 1981.

Foley, Richard, "Energy Education and Industrial Arts Education: Developing a Perspective for Policy Decision-Making." Unpublished comprehensive paper, University of Massachusetts at Amherst, 1982.

Franta, Gregory, "ASES Directors' Report." Denver: American Solar Energy Society, Inc., 1982.

Gierke, David, "Energy Education: Teaching Renewable Energy through Industrial Arts." Copyrighted monograph, presented at New Hampshire Industrial Education Association -- sponsored workshop, "Power and Energy" Keene State College, Keene, New Hampshire, April, 1982.

Grossman, R., and Daneker, G., Guide to Jobs and Energy. Washington, D.C.: Environmentals for Full Employment, 1978.

Hall, Timothy, "Energy Conservation: An Analysis of Public Policy Formulation, Implementation, and Alternatives." Ph.D. dissertation, University Microfilms International, The University of Oklahoma, 1979.

Hansen, Shirley, "Energy Education and Elementary and Secondary Schools." In Meeting Energy Workforce Needs, pp. 206-211. Silver Spring, Maryland: Information Dynamics, Inc., 1979.

Hayes, Denis, "ASES Directors' Report." Denver: American Solar Energy Society, Inc., 1982.

Hicks, Nancy, "Energy Guidelines for School Facilities." Ed.D. (abstract), East Tennessee State, 1978.

Hirsh, Robert, and Cochran, Thomas, An Analysis of the Carter Administration FY 1978 ENDA Budget. Washington, D.C.: Government Printing Office, 1977.

Horwitch, Mel, "Coal: Constrained Abundance." In Energy Future, Stobaugh, R., and Yergin, D. (Ed.), pp. 79-109. New York: Random House, 1979.

Hubbert, M. King, "Survey of World Energy Resources." In Perspectives on Energy: Issues, Ideas, and Environmental Dilemmas, Ruedisili, L., and Firebaugh, M., (Ed.). New York: Oxford University Press, 1975.

Hubbert, M. King, "The Energy Resources of the Earth." In Scientific American, V. 224, No. 3, pp. 60-70, 1971.

Hutchinson, Thomas and Associates, "Evaluation Methodology" Amherst, MA: University of Massachusetts. CO-OP. 1975.

Kelly, Henry and Garvell, Karl, (Ed.), A New Prosperity: Building a Sustainable Energy Future. The SERI Solar/Conservation Study. Andover, Massachusetts: Brick House Publishing, 1981.

Kerlinger, Fred N., Foundations of Behavioral Research. New York: Holt, Rinehart and Winston, 1973.

Kenick, Lois, "Energy Teaching Center." In Energy and Education: Teaching Alternatives, Posthuma, F. (Ed.), pp. 9-15. Washington, D.C.: National Education Association, 1978.

Kleinbach, M., "Survey of Industrial Arts Teacher Programs Regarding Content of Energy Courses and Programs." Unpublished report. State University of New York at Oswego, 1981.

Kryger, King, "Some Guidelines for Energy Programs." In Energy and Education: Teaching Alternatives, Posthuma, F. (Ed.), pp. 49-53. Washington, D.C.: National Education Association, 1978.

Levy, Girard, "Solar Energy Employment." In Meeting Energy Workforce Needs, pp. 38-43. Silver Spring, Maryland: Information Dynamics, Inc., 1978.

Lindbeck, John, Practical Guide to Industrial Arts Education. New York: The Center for Applied Research in Education, Inc., 1972.

Lipka, Jerry M., "Major Concerns in Social Ecology and New Directions for Improvement of Secondary School Curricula." Ed.D. dissertation, University of Massachusetts, Amherst, MA, 1980.

Lovins, Amory, Soft Energy Paths: Toward a Durable Peace. Cambridge, Massachusetts: Ballinger Publishing Company, 1977.

Lovins, Amory, World Energy Strategies: Facts, Issues, and Options. New York: Harper and Row Publishers, Inc., 1975.

Magid, Lawrence Jr., "Self-Perceived Human and Social Service Needs of Hampshire County, Massachusetts' Low Income Population." Ed.D. dissertation, University of Massachusetts, Amherst, MA, 1981.

Mahoney, James, "Energy Education Program Development in Two-Year Post-Secondary Institutions: A Look at National Surveys." Mimeograph. Energy Communications Center, American Association of Community and Junior Colleges, 1979.

Maidique, Modesto, "Solar America." In Energy Future, Stobaugh, R., and Yergin, D. (Ed.), pp. 183-215. New York: Random House, 1979.

Martin, Ann, "Energy, Education, and Economic Development." In Meeting Energy Workforce Needs, pp. 236-247. Silver Spring, Maryland: Information Dynamics, Inc., 1979.

Mason, Robert, "Education in the Department of Energy." Memorandum to Directors, Educational Programs Division, Department of Energy, Washington, D.C., 1978.

McDaniel, Bruce, "Solar Energy and the American Social Economy." Ph.D. dissertation (abstract), Colorado State University, 1979.

Nie, Norman N. et al., Statistical Package for the Social Sciences. New York: McGraw-Hill Book Company, 1975.

O'Connor, Kevin, "Training Programs and Advanced Education in Solar Energy." In Meeting Energy Workforce Needs, pp. 258-279. Silver Spring, Maryland: Information Dynamics, Inc., 1980.

Office of Education, "Improving Industrial Arts Teaching, A Conference Report." Washington, D.C.: U.S. Government Printing Office, 1960.

Petrock, Edith, "Linkage Efforts Among the States." In Meeting Energy Workforce Needs, pp. 334-339. Silver Spring, Maryland: Information Dynamics, Inc., 1973.

Posthuma, Frederick, "Foreward." In Energy and Education: Teaching Alternatives, Posthuma, F. (Ed.), pp. 7-8. Washington, D.C.: National Education Association, 1978.

Rhodes, Steven, "Organizing for Energy: The Federal Nuclear Model and Contemporary Solar Energy Policy." Ph.D. (abstract), University of Colorado at Boulder, 1980.

Rhyne, Samuel, "The Impact of Current Conservation on School Design and Operations in Selected North Carolina School Systems." Ed.D. (abstract), Duke University, 1977.

Rosenthal, Neal, "The Future Workforce Requirements in Energy Producing Industries." In Meeting Energy Workforce Needs, pp. 22-27. Silver Spring, Maryland: Information Dynamics, Inc., 1978.

Russell, E. B., "Measurement of the Change Orientation of Vocational Teachers." Unpublished doctoral dissertation, The Ohio State University, 1972.

Seligman, Martin, Helplessness: On Depression, Development, and Death. San Francisco: W.H. Freeman and Company, 1975.

Seltzer, Norman, "Energy Development -- Is There a Need for More People?" In Meeting Energy Workforce Needs, pp. 14-21. Silver Spring, Maryland: Information Dynamics, Inc., 1979.

Seum, Jack, "A Profile of Energy Education Programs." In Meeting Energy Workforce Needs, pp. 141-156. Silver Spring, Maryland: Information Dynamics, Inc., 1979.

Smith, William, "Education's Role in Meeting Energy Workforce Needs." In Meeting Energy Workforce Needs, pp. 9-13. Silver Spring, Maryland: Information Dynamics, Inc., 1979.

SPSS, Inc., SPSS-X User's Guide. New York: McGraw-Hill Book Company, 1983.

Standards for Industrial Arts Programs Project Staff, "Trends in Industrial Arts -- 1980." In Industrial Education, Vol. 69, No. 7, pp. 10-11, 1980.

Stevenson, Wayne, "Employment, Education, and Training Implications of the National Energy Act." Report submitted to Division of Labor Affairs and Manpower Assessment, Department of Energy, Washington, D.C., 1979.

Stobaugh, Robert, "After the Peak." In Energy Future, Stobaugh, R., and Yergin, D. (Ed.), pp. 16-55. New York: Random House, 1979.

Stobaugh, Robert, and Yergin, Daniel, "The End of Easy Oil." In Energy Future, Stobaugh, R., and Yergin, D. (Ed.), pp. 3-15. New York: Random House, 1979.

Stobaugh, Robert, and Yergin, Daniel, "Conclusion: Toward a Balanced Energy Program." In Energy Future, Stobaugh, R., and Yergin, D. (Ed.), pp. 216-233. New York: Random House, 1979.

Thayer, W. R., "Factors Associated with the Development of a Methodology for the Dissemination of Educational Innovations: A Re-examination." Ph.D. dissertation, The University of Michigan, 1981.

Thompson, John, Foundations of Vocational Education. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1973.

Welsh, W. A., "The Development and Field Testing of a Methodology for the Dissemination of Innovations." Ph.D. dissertation, The University of Michigan, 1976.

Wilber, Gordon, Industrial Arts in General Education. Scranton, Pennsylvania: International Textbook Company, 1967.

Wolf, William C., Jr., "Systematic Communication of Educational Innovations: A Synoptic History of Research and Practice." Viewpoints, 54: 57-70, 1978.

Wolf, William C., Jr., "Finding Knowledge Procedures and Users." Planning and Changing. 10: 48-63, 1979.

Wolf, William C., Linking Knowledge Production and Needs of Knowledge Users. Unpublished monograph in evolution, University of Massachusetts at Amherst, 1983a.

Wolf, William C., The Wolf Knowledge Diffusion/Utilization Inventory. Unpublished monograph in evolution, University of Massachusetts at Amherst, 1983b.

Wolf, William C., Wolf-Welsh Linkage Methodology. Unpublished monograph in evolution, University of Massachusetts at Amherst, 1983c.

Wolf, William C., "Linking Knowledge Production and Needs of Knowledge Users." In Instructional Development: The State of the Art, II, Bass, Ronald and Dills, Charles. Dubuque, Iowa: Kendall/Hunt Publishing Company, 1984.

Wolf, William C., Jr. and Fiorino, A., "Some Perspectives of Educational Change." Educational Forum. 38: 79-84, 1973.

Yergin, Daniel, "Conservation: The Key Energy SOURCE." In Energy Future, Stobaugh, R., and Yergin, D. (Ed.), pp. 136-182. New York: Random House, 1979.

APPENDIX A.

1. Energy Expert Nomination/Cover Letter and Response Sheet
2. Energy Expert Identification and Records

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

August 7, 1984

<N>

Dear <S>:

This letter is written to request your cooperation in a research study being conducted in the field of energy conservation and renewable energy education. I am an instructor at Keene State College, working in the Industrial Education and Technology Department and responsible for teacher-training in energy and power. Presently, I am completing my doctoral studies at the University of Massachusetts at Amherst in the field of occupational education. The area of my dissertation is a needs analysis, and this study is an attempt to identify what New Hampshire's industrial arts teachers need to know in order to teach energy conservation and renewable energy education.

New knowledge may or may not become a successful innovation based on two general conditions: first, the intrinsic value of the new knowledge relative to existing knowledge, and secondly, the selection process itself. In the case of new knowledge involving energy conservation and renewable energy, the intrinsic value has been well-documented by a range of experts - from Amory Lovins to local energy auditors. The major problem for public education's linkage with renewable energy is the selection process. And this selection process can only be initiated by identifying the "knowledge producers", the experts in energy conservation and renewable energy.

I need your assistance then in identifying those individuals, who in your opinion, meet the following criteria and have gained recognition as experts in the field of energy conservation and renewable energy. The criteria is simply that these individuals 1) work in the area of energy conservation, 2) are oriented to practices appropriate to the State of New Hampshire, 3) have exhibited technical expertise in their area, 4) have the ability to communicate their knowledge as shown by presentations and/or publications, work with professional/trade associations, or educational efforts.

Please submit the names (up to 25) of individuals who qualify as renewable energy experts.

I want to thank you in advance for your cooperation and contribution to the field of renewable energy education.

Sincerely,

Richard L. Foley, Instructor
Industrial Education and Technology

RENEWABLE ENERGY EXPERTS NOMINEE LIST

	NAME	ADDRESS
1.		
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NAME	ADDRESS
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22. ______________________	______________________
23. ______________________	______________________
24. ______________________	______________________
25. ______________________	______________________

ENERGY EXPERT IDENTIFICATION AND RECORDS

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
001	ID	X	RES		022 034 036 043 048 169 125 164 147 038 067 177 160 171 158 014 089 039 186 091 051
002	ID	X	RES		039 043 048 038 144
003	ID	X	RES	X	003 010 043 048 038
004	ID	X	RES	X	004 007 010 016 034 039 043 048 191 169 032 164 147 152 038 082 165 067 177 160 171 089 168 017 012 051
005	ID	X	RES	X	005 043 048 045 038
006	ID	X	RES	X	006 035 043 048 125 038 067 177 162 031 026
007	ID	X	RES	X	007 037 043 048 038 051
008	ID	X	RES	X	008 043 048 038
009	ID	X	RES	X	043 048 038 002
010	ID	X	RES	X	002 003 020 037 043 046 048 038
011	ID	X			043 048 038
012	ID	X			043 048 038
013	ID	X	RES	X	037 043 048 038 129 015
014	ID	X	RES	X	035 039 043 048 038 129 039 026 015
015	ID	X	RES	X	043 048 038 015 031
016	ID	X	RES	X	037 043 048 038
017	ID	X	RES	X	016 037 043 048 147 038 082 067 177 089 186
018	ID	X	RES	X	043 048 038 017
019	ID	X	RES	X	003 005 020 028 035 043 048 038
020	ID	X	RES	X	002 003 010 043 048 049 038
021	ID	X	RES	X	035 042 043 044 048 050 045 038 082
022	ID	X	RES	X	001 006 022 023 024 034 036 043 048 169 045 125 038 082 190 160 087 014 089 153 186 091 051

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
023	ID	X	RES	X	043 048 038 031
024	ID	X	RES	X	001 006 022 023 024 034 036 043 048 125 038 082 160 087 014 153 136 091
025	ID	X	RES	X	003 010 043 048 164 038 082
026	ID	X	RES	X	043 006 048 038
027	ID	X			043 048 038
028	ID	X	RES	X	002 013 020 028 043 048 038
029	ID	X	See 277		016 021 025 043 048 191 045 147 038 082 067 177 017 151 051
030	ID				043 048 038
031	ID	X	RES	X	011 034 043 048 191 038 067 177 160 087 158 031 161 091
032	ID	X	RES	X	016 023 043 048 038 082 165 162
033	ID		RES	X	035 043 048 191 169 159 038 177 067 088 158 031 168 153 151 051
034	ID		Moved		043 048 147 038 082 067 177 087
035	ID	X			043 048 038
036	ID	X	RES		001 006 018 022 023 024 034 036 043 048 125 038 082 160 087 031 014 089 153 186 161 091 051
037	ID	X	RES	X	18 037 043 048 184 038 012 144
038	ID	X	RES	X	043 048 169 184 038 082 039 026 015
039	ID	X	RES	X	035 043 048 050 038 039
040	ID	X	RES	X	035 037 043 048 169 045 038 129 012 144
041	ID		RES		009 043 048 164 159 038 137
042	ID	X	RES	X	005 018 021 037 042 043 042 048 050 045 038 012
043	ID	X	RES		043 048 038 039
044	ID	X	RES		042 043 044 048 045 038

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
045	ID	X	RES	X	005 043 048 038 168 039
046	ID	X	RES	X	043 048 038 018 010
047	ID	X	RES	X	043 048 038 165
048	ID	X	RES	X	008 016 021 035 043 048 050 184 038 082 039 026 015 144
049	ID	X	RES	X	002 020 043 044 048 164 038 082 015
050	ID	X	RES	X	005 019 043 048 045 038
051	ID	X	RES	X	004 007 025 045 032 067 177 160
052			RES	X	007 043 048 038
053			RES	X	007 043 048 038
054					007
055	ID	X	RES	X	004 005 006 018 019 021 024 036 042 044 050 191 169 125 152 154 082 067 177 039 186 012 057 015 016 022 023 036 045
056			RES	X	016 022 023 036 045
057			RES	X	004 016 006 022 034 036 125 087 017 012
058					016
059					016
060			RES	X	010 002 026 020 137
061					003 010
062			RES	X	002 003 009 010 021 037 137
063					010
064					010
065					010
066					010
067	ID	X	RES	X	067 191 169 164 159 157 158 089 168
068					008

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
069					008
070					008
071					008 026
072					008
073					008
074					008
075					008
076					008 035
077					022 036 087
078			RES	X	022 034 036 125 087 017
079					005
080			RES	X	024 036 145 039
081			RES		011 024 036 082
082	ID	X	RES	X	024 036 037 032 067 177 088 172
083			RES	X	034 088 031 087
084					034 179
085					030 179
086			RES	X	034 179 088 089 176
087	ID	X			034 067 177
088	ID	X			034 169 164 067 177 088 158 186
089	ID	X	RES	X	034 147 152 166 067 177 051
090					034 160
091	ID	X			034 067 177
092					034
093					034 179
094			RES	X	034 191 159 151

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
095					034
096					034
097					034
098					034
099					034
100					034
101			RES		004 023 034 045 017 186
102			RES	X	034 043 048 152 038 057
103					039
104					037 152
105					037
106					037
107					037
108					039 082
109					037
110					039
111					037
112					002
113					028
114					028
115			RES	X	028 013 043 048 038
116					028
117					019 045 039
118					019 050
119					019
120					023

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
121					023 082
122					023
123					023
124					023
125	ID	X	RES	X	035 125 147 067 177
126					035 045
127			RES	X	013 129 031 039
128			RES	X	013 082 129 031 039
129	ID	X	RES	X	013 044 087 179 031 014
130					013
131					013
132					013 015
133					013
134					013
135					013
136					050
137	ID	X	RES	X	009 043 048 038 137
138					009
139					009
140					046
141					046
142					046
143			RES	X	043 048 038 039
144	ID	X	RES	X	043 048 038 146
145	ID	X	RES	X	043 048 145 038
146	ID	X	RES	X	067 177 091 146

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
147	ID	X	RES	X	067 177 091 089
148	ID	X			152 067 177
149	ID	X	RES	X	007 177 168 034 161
150	ID				067 177
151	ID	X	RES	X	179 169 164 159 157 067 177
152	ID	X			067 177
153	ID	X	RES	X	067 177 153 034 161
154	ID	X	RES	X	154 067 177 153
155					067 177
156			Sabbatical		159 067 177 151
157	ID	X			157 067 177
158	ID	X			164 158
159	ID	X	RES	X	125 174 159 067 177
160	ID	X			067 177
161	ID	X			067 177 153
162	ID	X			067 177 162
163					067 177
164	ID	X	RES	X	164 067 177 151
165	ID	X			165 067 177
166	ID	X			166 067 177
167					067
168	ID				067 177
169	ID	X	RES	X	191 169 067 177 158
170					191
171	ID	X	RES	X	191 067 177 171
172	ID	X			067 177

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
173	ID		RES	X	067 177 158 161
174	ID	X			159 067 177
175	ID				067 177
176	ID	X			191 067 177
177	ID	X			067 177
178	ID				067 177
179	ID	X	RES	X	067 177 179 089
180	ID	X			067 177
180	ID	X			067 177
182					191
183	ID	X			067 177
184	ID	X	RES	X	184 067 177 179
185	ID	X	RES	X	067 177 179 176
186	ID	X	RES	X	067 177 017 186
187					067 177
188	ID				067 177
189					067 177
190	ID	X			067 177
191	ID	X	RES	X	179 191 067 177
192					191
193					191
194					191
195					191
196					045
197					045
198					045

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
199					045
200					045
201					045
202					045
203					045
204					045
205					125 147 151
206					125
207					125 087
208					145
209					145
210					145
211					145
212					145
213					145
214					145
215					164
216					164
217					164
218					164
219					147
220					147
221					147
222					147
223					147
224					147

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
225					147 067
226			RES	X	147 152 164 067 177 089
227					152
228			RES	X	159 151 168 026 151
229					049
230			RES	X	152 164 148 089
231					049 015
232					049
233					049
234					174
235					174
236					174
237					174
238					184
239					166
240					166
241					166
242					166
243					166
244					166
245					166
246					159
247					154
248					082 031
249					082
250			RES	X	082 031 158 014 015

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
251					082
252					082
253					183
254					082 039
255					183
256					157
257					157
258					157
259					157
260					185
261					185
262			RES	X	160 017 014 168 151
263					160
264					162
265					088
266			RES	X	088 089 014 168 151
267					088
268					087
269					087
270					087
271					087
272					172
273					172
274			RES	X	171 089 091 144 151
275					171
276					158

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
277			RES	X	158 (See nominations for 029)
278					031
279					031
280					031
281					014
282					014
283					014
284					014
285					014
286					089
287					089
288					089
289			RES	X	152 164 089 168 148
290					168
291					168
292					168
293					168
294					168
295					039
296					039
297					039
298					039
299					039
300					039
301					137
302					137

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
303					137
304					137
305					017
306					148
307					026
308					026
309					026
310					026
311					151
312					151
313					151
314					151
315					151
316					091
317					091
318					091
319					091
320					146
321					146
322					146
323					146
324					146
325					146
326					146
327					146

ID NO.	ID ROLE	RET.	RES	RET.	NOMINATIONS
328					146
329					146
330					012
331					012
332					012
333					012
334					051
335					051
336					015
337					015
338					144
339					144
340					144
341					144
342					144
343					144
344					144

ENERGY EXPERTS: Records and Response Rates

Identification Requests		Returns	Response Rate
101		92	91%
Nominations	Expert Status		Expert-Nominee Percentage
344	96		28%
RES Surveys		Returns	Response Rate
96		88	92%

APPENDIX B.

1. Expert Definer Stimulus Question: Option #1
2. Expert Definer Stimulus Question: Option #2
3. Expert Definer Stimulus Question: Option #3
4. Expert Definer: Cover Letter and Survey Instrument
5. Teacher Definer: Cover Letter and Survey Instrument

Stimulus Question: Option #1

Imagine that the state of New Hampshire had responded to the current, national focus on the goals and quality of public education as highlighted by the report, A Nation at Risk, with revised standards for public education and an increased state-level financial commitment to local schools. As part of this revitalization process, renewable energy education had been elevated to a major priority level. And lastly, a state plan for implementing a comprehensive program of renewable energy education (grades kindergarten through twelve) had been successfully carried out by local schools.

Let's also assume that the state's radical redefinition of energy education was built on three assumptions. The first assumption is that energy conservation is more accurately defined as an energy source, and that it is classified under the umbrella phase--renewable energy source. The second assumption is that political, economic, social and environmental impacts generated by a decentralized system of renewable energy source and their conversion technologies are also positive and beneficial. And lastly, the following outline of renewable energy sources and technologies is an appropriate scheme for organizational purposes:

I. Energy conservation

II. Thermal (heating and cooling application)
- o heating and cooling of buildings
- o heating of water
- o agricultural and industrial process heating

III. Fuels from biomass
- o plant matter, including wood and waste

IV. Solar electric
- o solar thermal electric
- o photo-voltaics
- o windmills
- o ocean thermal electric
- o hydropower

Given this scenario, imagine further that the state's approximately 300 industrial arts teachers are involved in an ongoing exemplary in-service program that will help them to acquire the knowledge to teach energy education within the context of the state's comprehensive, K through 12 renewable energy curriculum.

As you think about this hypothetical in-service program, what things are being taught that will meet these industrial arts teachers' needs for knowledge to teach energy conservation and renewable energy education? Please make a list of those items.

Stimulus Question: Option #2

Imagine that New Hampshire's industrial arts teachers are providing instruction in renewable energy education as part of a comprehensive, K through 12 program in conservation and renewable energy education that is on-going in all of the state's public schools. As you observe this situation in your mind, what are the things that indicate to you that the industrial arts teachers' needs for knowledge to teach renewable energy education is being met?

Stimulus Question: Option #3

Imagine that all of New Hampshire's industrial arts teachers are providing instruction in renewable energy education. Furthermore, their efforts are contributing to a comprehensive, kindergarten through twelfth grade program in energy conservation and renewable energy education that is operating successfully in the state's public schools.

Given this scenario, imagine further that the state's approximately 300 industrial arts teachers are involved in an ongoing exemplary in-service program that will help them to acquire the knowledge to teach energy education within the context of the state's comprehensive renewable energy education curriculum.

As you think about this hypothetical in-service program, what things are being taught that will meet these industrial arts teachers' needs for knowledge to teach energy conservation and renewable energy education? Please make a list of those items.

May 23, 1984

Dear

This letter is a request for your help in bringing energy conservation and renewable energy education to the public schools in New Hampshire. Although the national focus on energy issues may have faded during the past decade, professional educators in New Hampshire are pooling their individual interests and state resources to promote renewable energy education in public schools. For the past four years, the State's industrial arts ("shop") teachers have continued to list renewable energy education as their number one area for technical updating. Last year, the State's guidelines for teaching industrial arts were amended to recognize, for the first time, energy conservation and alternative energy as content areas comparable to more traditional programs in woods, metals, drafting, etc. And most significantly, the proposed revision of the State's standards for high school-level education has singled out industrial arts programs in energy as a top priority. Leaders in New Hampshire public education are gearing up to deliver renewable energy education.

I am an instructor at Keene State College, responsible for the training of industrial arts teachers in the area of power and energy. Given the revived, state-level interest in renewable energy education, I have focused my dissertation work at the University of Massachusetts at Amherst on the problem of identifying what New Hampshire's nearly three hundred industrial arts teachers need to know in order to teach energy conservation and renewable energy education.

In order for industrial arts teachers to introduce renewable energy education into the public schools, we must find out what the "experts" would select as appropriate subject matter. The identification of renewable energy experts was the first major objective of this study. During the past two months, leaders in the area of renewable energy have responded to a request to help identify experts in energy conservation and renewable energy--people who are oriented to practices appropriate to New Hampshire, have exhibited technical expertise in their field, and have the ability to communicate their knowledge. From a list of nearly two hundred names, forty-two individuals have received substantial peer support.

Page 2

Given these forty-two "experts", I have selected twelve people who represent various points of view of the expert group, to provide the most critical information for this study--what industrial arts teachers need to know in order to teach renewable energy education.

Your task is to respond to the open-ended question outlined on the attached sheet. A stamped, addressed envelope is enclosed for your convenience.

This request, I realize, is directed at people who are busy. I want to thank you in advance for your cooperation in supporting a practical, realistic effort to introduce and promote renewable energy education in the public schools of New Hampshire.

Sincerely,

Richard L. Foley, Instructor
Industrial Education and Technology

RLF:wpc

Enc:

Definition of Industrial Arts

Industrial arts is the segment of general education that deals with industry--its organization, materials, occupations, processes, and products, and the problems resulting from the industrial and technological nature of society. The majority of "shop" courses are offered in traditional areas such as woodworking, drafting, metals, small engine repair, consumer automechanics, graphic arts, machine shop, electricity/electronics, plastics, and general lab. Some schools are introducing broader-based courses in material processing, visual communication, and power and energy.

Open-Ended Question

Imagine that all of New Hampshire's industrial arts teachers are providing instruction in renewable energy education. Furthermore, their efforts are contributing to a comprehensive, kindergarten through twelfth grade program in energy conservation and renewable energy education that is operating successfully in the State's public schools.

Given this scenario, imagine further that the State's more than 300 industrial arts teachers are successfully presenting concepts and developing lab activities that are helping students in both junior and senior high school programs to learn about energy use, conservation, and renewable energy sources.

As you think about what would be successful efforts, what information would the industrial arts teachers have that would meet their needs for knowledge to teach energy conservation and renewable energy education. Please make a list of that information.

Open-Ended Question Response

What information would industrial arts teachers have that would meet their needs for knowledge to teach energy conservation and renewable energy education?

1. ____________________
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25. ____________________

(over)

May 23, 1984

Dear

This letter is a request for your help in bringing energy conservation and renewable energy education to the public schools in New Hampshire. Although the national focus on energy issues may have faded during the past decade, professional educators in New Hampshire are pooling their individual interests and state resources to promote renewable energy education in public schools. For the past four years, you and your teaching colleagues, the State's industrial arts teachers have continued to list renewable energy education as an important area for technical updating.

Last year, the State's guidelines for teaching industrial arts were amended to recognize, for the first time, energy conservation and alternative energy as content areas comparable to more traditional programs in woods, metals, drafting, etc.. And most significantly, the proposed revision of the State's standards for high school-level education has singled out industrial arts programs in energy as a top priority. Leaders in New Hampshire public education are gearing up to deliver renewable energy education.

I am an instructor at Keene State College, responsible for the training of industrial arts teachers in the area of power and energy. Given the revived, state-level interest in renewable energy education, I have focused my dissertation work at the University of Massachusetts at Amherst on the problem of identifying what New Hampshire's nearly three hundred industrial arts teachers need to know in order to teach energy conservation and renewable energy education.

I need your assistance in identifying what industrial arts teachers need to know in order to teach energy conservation and renewable energy education. Your task is to respond to the open-ended questionnaire outlined on the attached sheet. A stamped, addressed envelope is enclosed for your convenience.

This request, I realize, is directed at people who are busy. I want to thank you in advance for your cooperation in supporting a practical, realistic effort to introduce and promote renewable energy education in the public schools of New Hampshire.

Sincerely,

Richard L. Foley, Instructor
Industrial Education and Technolody

Enc.

Open-Ended Question

Imagine that all of New Hampshire's industrial arts teachers are providing instruction in renewable energy education. Furthermore, their efforts are contributing to a comprehensive, kindergarten through twelfth grade program in energy conservation and renewable energy education that is operating successfully in the state's public schools.

Let's also assume that the State's definition of energy education is built on three assumptions. The first assumption is that energy conservation is more accurately defined as a renewable energy source. The second assumption is that the political, economic, social and environmental impacts generated by a decentralized system of renewable energy sources and their conversion technologies are also positive and beneficial. And lastly, the following outline of renewable energy sources and technologies is an appropriate scheme for organizational purposes:

I. Energy conservation
II. Thermal (heating and cooling applications)
   - o heating and cooling of buildings
   - o heating of water
   - o agricultural and industrial process heating

III. Fuels from biomass
   - o plant matter, including wood and waste

IV. Solar electric
   - o solar thermal electric
   - o photo-voltaics
   - o windmills
   - o ocean thermal electric
   - o hydropower

Given this scenario, imagine further that the State's more than 300 industrial arts teachers are successfully presenting concepts and developing la activities that are helping students in both junior and senior high programs to learn about energy use, conservation, and renewable energy sources.

As you think about these successful efforts, what information would the industrial arts teachers have that would meet their needs for knowledge to teach energy conservation and renewable energy education. Please make a list on the enclosed sheet of what these teachers learned.

Open-Ended Question Response

What information would industrial arts teachers have that would meet their needs for knowledge to teach energy conservation and renewable energy education?

1. ______________________________
2. ______________________________
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(over)

Stimulus Question Response (continued)

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APPENDIX C.

1. Subject Content Areas for Industrial Arts Teachers
2. Teacher Definers: Data for Stratified Sample
3. Teacher Definer: Sample Response

SUBJECT CONTENT AREAS FOR INDUSTRIAL ARTS TEACHERS

(Based on 1983-1984 Industrial Education Teacher Directory)

Content Areas	Number of Teachers
Elementary/Comprehensive	1
El.-Jr. High Comprehensive	0
Jr. High Comprehensive	49
Jr. High Comprehensive/Jr. Crafts	6
Jr. High Comprehensive/Sr. Crafts	20
Jr. High Crafts	37
Jr./Sr. High Comprehensive	7
Sr. High Comprehensive	21
Sr. High Comprehensive/Crafts	14
Sr. High Single Craft Areas	
wood	27
drafting	20
metals/welding	11
machine shop	3
graphic arts	12
small engines	6
automechanics/power	10
electricity/electronics	6
Sr. High Combination Craft Areas	
wood/metals	7
metals/drafting	1
metals/machine shop	2
small engines/metals	4
electricity/electronics/drafting	5
auto/power mechanics/machine shop	4
building maintenance	3
electricity/graphic arts	1
wood/power	1
graphics/metals	2
3 or more craft areas	25
Private/Hospital/etc.	9

TEACHER DEFINERS: DATA FOR STRATIFIED SAMPLE

ID No.	Name	Definer Response	Area of Representation
178	Paul Beaudoin	X	Experienced, regional Sr. H.S., electronics, graphics
044	Connie Bergeron	X	Recent KSC grad., private school, electronics, drafting
008	Dan Caron	X	NHIEA leader, recent KSC grad., Jr. H.S., comprehensive
198	Roland Cournoyer	X	Experienced, dual certificate, power and energy, large urban Jr. H.S.
320	Dale Courtney	X	Multiple areas, comprehensive lab, small/rural school, experienced
222	Paul Cuetara	X	Comprehensive lab, Jr./Sr. H.S.
138	Ben Daycock	X	Vocational Ed/IA, alternative energy interest and part-time business, rural school
215	Peter Desautels	X	Large urban Sr. H.S., electricity/electronics, IA Teacher-of-the-year
324	Charles Horshin	X	Industrial background, alternative energy interest, electronics, metals, Sr. H.S., rural school
311	Jim Keegal	X	Experienced, automechanics, power and energy, Sr. H.S.
258	Al Lofgren	X	Recent KSC graduate, alternative energy interest
027	Dick Merrill	X	Urban, experienced, Jr. H.S.
083	Lynda Plunkett	X	Dual certificate, drafting, science
146	Peg Shaefer	X	Jr./Sr. H.S., graphics
249	Ray Tode	X	Experienced, comprehensive lab, Jr. H.S., graphics, IA teacher-of-the-year

TEACHER DEFINER: SAMPLE RESPONSE

Alternative energy as we call it here is a 2 week 3 week section of the power mechanics course. Depending on size of classes and intelligence of the group the following areas are covered:

1. Solar energy - Types of collectors
   Site selection
   Solar gain--seasonal change
   Necessary angles, etc.

   Construction of solar heater--"Beer Box" Heaters, stressing insulation, absorbtion, cover plates, etc. 3 tests made--heat up time, max temp., and heat retention.

2. Bio gas - Production of methane--use of manure, rotting vegetation. Collect about 3 cubic feet which we run on 1 cyl. engine for about 2 min.

3. Solar voltaic cells--set up a few cells to show possibilities.

4. Wood--(Renewable) Heat-Basic safety and a bit on the catalytic converter.

5. Geo Thermal--ground water pumped up in winter time to supply heat. (Several lake houses are doing this as a seasonal heating source)

Where did I get this information---<u>not</u> from colleges I dare say. Most was gleaned from building industry work shops, IA work shops, my own interest, and reading. I built my own solar HW system (active) so I went through all the research and problems.

On the High School level these students want to see results as they are still skeptical on any energy decline as they know it.

Solar, is the easiest and most dramatic.

Well water pumped out in -10° weather showing a heat potential of 52° is real to them.

Wood burning is real as they use it as a cost reduction.

Anything presented i.e., theory, will have to be shown by actual operating models to have any effect. We do tell ours of tidal, hydro. (they have seen the) geothermal, etc.. The ones that stick are the ones that they can be active in and have a practical use.

APPENDIX D.

1. Energy Expert Definers: Data for Stratified Sample

2. Energy Expert Definer: Sample Response

3. Thank You Letter with Insert

Energy Expert Definers: Data for Stratified Sample

ID No.	Definer* and Back-up Definer(s)	Response	Variables Represented
102	L. Audette*	X	engineer, biomass, photovoltaics,
145	G. Wells	X	contracting, research
006	J. Christopher*	X	engineer, manufacturer, wholesaler,
036	V. Reno	X	research, active systems
026	P. Lunde	X	
180	M. Drabick*	X	micro-hydro, mini-hydro, contractor
144	W. Loeb		
010	H. Faulkner*	X	architect, educator, research,
055	D. Gillette	X	energy conservation, superinsulation
053	C. High*	X	education, engineer, research,
052	J. Hornig	X	conservation, heating and cooling,
007	A. Converse	X	wood-burning technology
019	T. Johnson*	X	architect, education, research,
081	J. Kirby	X	industrial consultant, glazing,
044	R. Thornton	X	daylighting, conservation
021	M. Kelley*	X	engineer, house manufacturer,
003	R. Beaulieu	X	conservation, heating and cooling, research
031	L. Measure*	X	contractor, retailer, manufacturer,
115	A. Perkins	X	heating and cooling, water-heating,
013	B. Hamilton	X	wood-burning equipment
032	D. Metz*	X	architect, author, conservation,
031	D. Booth	X	heating and cooling
082	M. Rosenbaum*	X	engineer, architect, education,
028	D. McCormick	X	conservation, heating and cooling,
022	J. Kohler	X	wood-burning, water heating
037	N. Saunders*	X	engineer, research, generalist,
024	D. Lewis	X	author
040	W. Shurcliff*	X	physicist, education, research,
049	C. Wing	X	author, conservation, generalist
001	B. Anderson	X	

ID No.	Definer* and Back-up Definer(s)	Response	Variables Represented
137	P. Talmage*	X	engineer, windpower, hydropower, photovoltaics, distributor, contractor
009	S. Dickson	X	
043	S. Strong	X	
045	G. Tully*	X	architect, industry, education, conservation, heating and cooling
025	W. Lotz	X	
057	C. Michal	X	
048	A. Wilson*	X	non-profit agency, generalist, education
062	B. Kent	X	
082	D. Lamont	X	
050	B. Wright*	X	engineer, education, generalist, computer applications
129	A. Segar	X	
042	R. O. Smith	X	

Expert Definer: Sample Response

May 26, 1984

Dear Rick,

I hope that the format of my response is acceptable. I'm at ease on my computer system, and your form is hard for me to type on.

There are two areas that I feel comfortable speaking out on: the first consists of thoughts on overview material which would help to give perspective at any grade level and would also be appropriate for lower grades; the second area is specific material requirements in conservation and renewable thermal processes.

First - Most Important Background Ideas.

Ultimately and always underlying enerything we design, compute, and project is a simple idea - the first law of thermodynamics. Since most people would say that first graders would never get the idea, I feel that I have to justify presentation of the idea. (It is certainly not necessary to present the 1st law by that name. It could be called any number of less imposing names.) Without our intuitive understanding of the first law, we could never even make it down to the store, or fill the bathtub. We all understand it, and anyone will understand the general idea that:

1. THE ENERGY WHICH PASSES INTO A SYSTEM (OR IS RELEASED WITHIN IT) MUST EITHER BE STORED WITHIN THE SYSTEM OR PASS OUT OF IT.

When applied at the planetary level, the simple fact that our planet is in a delicate equilibrium with our sun and deep space is apparent. Every minute of every day the sun pours out its radiation on us, and likewise, our atmosphere reflects some away, and our planet radiates some away, due to the fact that the planet is much warmer than space. While there are several ideas in the example, once one gets the basic concept of energy pouring in and out simultaneously, it becomes easy to understand that energy use on the planet can influence the temperature of the planet, and change the equilibrium.

The imperative of renewable energy is absolute, unless we find means to discharge the "generated" energies (i.e. combustion or nuclear) into space. While these energy sources upset the current planet balance, renewable energies are generally only ones which redistribute the current energy flows. For example a solar power plant converts the usual flow into a form of energy which can be piped off to some place where the surface solar flux is usually not so high (while this may have micro effects, it at least will not disturb the major balance). Wind power, tidal power, direct solar power, solar thermal -- these are all redistribution strategies which we must ultimately turn to. The first law of thermo is so simple and compelling that it must be taught early on, and used as a starting point for all subsequent work.

(I have to point out that I taught first grade science this past fall and it's pretty clear to me that it would work -- a fresh approach to science teaching is needed, but the kids would love it. It would be feasible to wind some very basic ideas into the standard science programs, and lay the foundations for later, more advanced work.)

At the national level, the first law can be seen to be helpful in understanding the replacement of non-renewable sources with those that are renewable.

As part of material which would be taught to your teachers, there are two more background ideas which I'd be sure not to miss:

2. CONSERVATION DOES NOT IMPLY DISCOMFORT - RATHER, CONSERVATION IMPLIES INCREASED LEVELS OF COMFORT.

3. THE COST OF CONSERVATION AND RENEWABLE ENERGIES IS LOWER THAN CONVENTIONAL ENERGIES WHEN THE ENTIRE LIFETIME OF THE ENERGY SYSTEM AND THE ENTIRE NATIONAL ECONOMY IS CONSIDERED.

For a long time now, I've wanted to write an article addressing #2, and the article would be entitled "Fast Cars and Passive Solar". Somehow you need to get the teachers (and their students) over the psychological hump of believing that renewable energy translates into suffering. Quite the reverse is true. The thermal comfort of a low energy house is right down the main street of the American desire to wallow in comfort. The very folks who like fast cars and toasty houses can currently sit around in their underwear all winter for free. Conservation and solar can be shown to increase the comfort index (side by side with conventional construction) for lower operating costs. I have never had the time to pull together the data and the computer runs to make the whole story clear, but the psychological plusses would go a long way to providing your teachers with strong incentive.

Idea number 3 is really a restatement of the conservation law, but applied across time and national scale systems. The favorite renewable homily, "You can pay me now or you can pay me later, BUT YOU ARE GOING TO PAY ME", applies to "Lifecycle costing" (a truly obnoxious term) in which first costs (or energies) are summed with oeprating costs over the life of the system. This is, of course, only another full systems approach. There is a surplus of material on this topic, and it would require a considerable effort to make it digestible, but the basic idea culd be introduced fairly early.

Second, specific ideas in the area of conservation and renewable thermal processes:

A. Techniques now in use in Conservation in Buildings

1. Insulation systems

insulation material types
appropriateness for use in walls, ceilings, floors, etc.
ventilation and condensation issues

2. Heat reclaim approaches

   types of heat exchangers - heat wheels, air to air, etc.
   importance of integration in HVAC systems

3. Mechanical systems revisited (assumes inclusion into HVAC material.

   first cost/operating cost tradeoffs
      high pressure vs low pressure
      air vs water as transport
   integrated thermal mass effects
   equipment sizing for low equilibrium design loads
   high efficiency motors
   variable speed drives for pumps and fans
   elimination of reheat and simultaneous heat/cooling
   opportunities for diurnal storage
   interaction with utility rates
   etc.

4. Envelope tightness/infiltration

   typical design and performance
   means of sealing envelopes - crack elimination
   acceptable levels of tightness and air quality
   importance of infiltration in cmml bldgs in NE
   when air-air exchangers are required
   construction details and lessons learned from the field
   measurement techniques - blower door and tracer gas
   impact of wind direction and stack effect
   etc.

5. Glazing systems

   types available - double, triple, heat mirror, etc.
   use of absorbing, reflective in comml bldgs
   importance of thermal break and sash construction
   impact on radiation comfort levels
   orientation and heating/cooling loads
   importance of mounting seals
   daylighting implications in comml bldgs

B. Techniques now in use in Passive Solar

1. Direct Gain systems

   what is it and how does it work - examples
   performance vs glazing type in NE
   importance of overheating controls - mass, aperture sizing
   impact of orientation on performance
   simple design patterns

2. Daylighting

   what is it and how does it work - examples
   glazing types
   internal distribution vs aperture, orientation
   cooling load tradeoffs
   internal surface reflectances

3. Sunspaces and greenhouses

   what is it and how does it work - examples
   orientation
   minimum temperatures effect on performance
   commercial greenhouse approaches
   connecting wall as impact on temperature swing and performance
   problems in connecting to living space
   impact of mass on temperature and on annual performance

4. Mass walls (Trombe, water, etc.)

   what is it and how does it work - examples
   time delay and thickness
   optimum storage to aperture ratio
   phase change walls
   vented versus unvented
   night insulation techniques

C. Addressing the ability to compute thermal benefits

1. First law of thermo
2. Sensible heat storage
3. Phase change heat storage
4. Conducting heat transfer
5. Linearized radiation heat transfer
6. Linearized convective transfer

While these sound like a college course in thermodynamics and heat transfer, they can be taught in their simplest forms, and with no great amount of math. (Simple algebra will suffice.) In my course at MIT, I am used to teaching Architects enough of the basics to allow them to be able to apply the ideas in buildings.

I could go on from here, and would end up outlining an entire textbook, but your time line and my spare time is such that I better stop here. The above is certainly not exhaustive, and thoughtful reflection would add, reorganize. If you think something is missing, it probably is, since the above is pretty much stream of counsciousness.

Bill Wright

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

June 20, 1984

<N>

Dear <S>:

I am writing to say thank you for responding to the renewable energy education questionnaire. The turn around time was tight, and the questionnaire was a difficult, open-ended one. <I> I genuinely appreciate your assistance with this study, and the progress to date is, in no small way, a direct result of your contribution.

Your comments, combined with those of a small number of "energy experts" and a small group of industrial arts teachers, formed a comprehensive list of what industrial arts teachers need to know in order to teach renewable energy education. This list will be evaluated by nearly one hundred identified "energy experts" and the more than three hundred New Hampshire industrial arts teachers. This evaluation form will be the last survey of this study, and will be mailed later next month.

In closing, let me say thank you again. You should have received your maple syrup by this time - via UPS. Please give me a call at 603-352-1909 Ext. 295 if the UPS folks have not been successful messengers. (Sometimes mailing addresses are not appropriate for this type of delivery.) Enjoy the syrup - great over ice cream in this summer weather, or for putting up strawberry jam!

Sincerely,

Richard L. Foley
Industrial Education and Technology

RLF/wpc

APPENDIX E.

1. Identified Needs: Theoretical Outline

2. Identified Needs: Modified Outline

3. Identified Needs: RES Introduction

Identified Needs: Theoretical Outline

I. Basic Energy Information

- o definitions of energy
- o energy consumption
- o energy transmission
- o energy storage

II. Energy Conservation

III. Thermal Applications

- o heating and cooling
- o heating of water
- o agricultural/industrial processes

IV. Fuels from Biomass

V. Solar Electricity

- o wind power
- o hydropower
- o photovoltaics

VI. Implications of Energy Decisions

VII. Delivery of Conservation and Renewable Energy Education (CREED) by IA Teachers

Identified Needs: Modified Outline

I. Basic Energy Information: Scientific Background

A. Energy and Power
B. Heat Energy
C. Energy Generation, Storage, Conversion, Distribution
D. Science Support

II. Basic Energy Information: Implications

A. History
B. Supply & Demand
C. Economics
D. Politics
E. Social
F. Environmental Concerns
G. Specific Issues

III. Conservation and Renewable Energy: Overview

A. History
B. Economics
C. Politics
D. Social
E. Environmental
F. Specific Issues
G. Science Support

IV. Conservation in Practice

A. Definitions
B. Economics
C. Residential/Commercial Buildings
D. Transportation
E. Industrial
F. Agricultural
G. Specific Issues

V. Thermal Applications

A. Heating and Cooling

1. Design
2. Passive
3. Active
4. HVAC
5. Insulation
6. Vapor Barriers
7. Glazings
8. Air: Air Exchangers
9. Sunspace/Greenhouse
10. Construction Skills

B. Heating of Water

1. Design
2. Passive
3. Active
4. HVAC
5. Installation

C. Wood-Burning Technology (space-heating, agricultural and industrial process heating)

1. Wood-burning technology
2. Agricultural/industrial process heating

VI. Solar Electric

A. Photovoltaics

1. Basics
2. Economics
3. Installation
4. Specifics

B. Windpower

1. Basics
2. Economics
3. Installation
4. Specifics

C. Hydropower

1. Basics
2. Economics
3. Installation
4. Specifics

D. Thermal and Ocean

VII. Biomass

A. Basics
B. Economics
C. Installation
D. Specifics

VIII. Delivery of Renewable Energy Education in Industrial Arts

A. Definitions
B. Curriculum
C. Direct Delivery Methods
D. Technical Support
E. Teacher Skills

Identified Needs: RES Introduction

I. BASIC ENERGY INFORMATION: SCIENTIFIC BACKGROUND

II. BASIC ENERGY INFORMATION: IMPLICATIONS

III. CONSERVATION AND RENEWABLE ENERGY: OVERVIEW

IV. CONSERVATION AND PRACTICE

V. THERMAL APPLICATIONS

A. HEATING AND COOLING
B. HEATING OF WATER
C. WOOD-BURNING TECHNOLOGY

VI. SOLAR ELECTRIC

A. PHOTOVOLTAICS
B. WINDPOWER
C. HYDROPOWER

VII. BIOMASS

VIII. DELIVERY OF RENEWABLE ENERGY EDUCATION IN INDUSTRIAL ARTS

APPENDIX F.

1. Expert Field-Test Respondents
2. Teacher Field-Test Respondents

EXPERT FIELD-TEST RESPONDENTS

Name	Comments
Russ Lanoie	o avoid "50¢ words" o follow an outlined format o lump items in better defined groupings o comprehensive coverage
Dolores Wolfe	o numerous editorial corrections o delete several items as redundant o survey takes too long to complete (1 hour) o group items by better defined topic areas (proposed outline provided)
Richard Gottlieb	o Very thorough coverage of topic areas o several editorial corrections o more items covering organic/greenhouse food production
William Shurcliff	o excellent coverage of topics o numerous editorial comments
Paul Peterson	o several editorial comments o comprehensive coverage
Alex Wilson	o several editorial comments o introductory outline needs to be stressed o excellent list of items

TEACHER FIELD-TEST RESPONDENTS

Name	Comments
Carl Fike	o excellent list of items o vocabulary is very technical o some teachers will know very little about some topic areas
Gaylord Shaw	o impressive list o really enjoyed the task of answering the survey
Ed Taylor	o excellent coverage of material o some teachers will not have the knowledge to respond to certain topics o editorial comments
Peter Sebastian	o nothing seems to be left out
Robert Clavelle	o perhaps vocabulary is too technical for teachers o comprehensive list of topics

APPENDIX G.

1. Cover Letter for Teachers
2. Follow-up Letter for Teachers
3. Teacher Data Sheet
4. Cover Letter for Energy Experts
5. Cover Letter for Energy Expert Definers
6. Expert Data Sheet
7. Renewable Energy Survey (Forms A and B)

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

August 30, 1984

<N>

Dear <S>:

I need your help in bringing renewable energy education into our State's industrial arts programs.

As an instructor at Keene State College, I am responsible for the training of industrial arts teachers in the area of power mechanics. Recently, the State's educators have been working to strengthen industrial arts programs in power and energy. For the past few years, industrial arts teachers have continued to list alternative energy as a top area for technical updating. The State's guidelines for teaching industrial arts now recognize energy conservation and alternative energy as content areas (comparable to woods, metals, drafting, etc.). This year, the State's revised standards for secondary education list "power and energy" as a top priority area for industrial arts.

I need your help then in identifying what industrial arts teachers need to know in order to teach renewable energy education. The enclosed survey represents the considerable efforts of 16 energy experts and 16 of your colleagues. Please read the directions carefully: you will simply be making check marks and circles. This task should not take you more than half an hour. It would probably be easier to do it now, than to put it off.

There is also a data sheet which will help you describe your professional preparation and teaching responsibilities. Please indicate on this form if you would like to receive a summary of this study's results.

This survey is directed at the more than 300 industrial arts teachers in our State and approximately ninety renewable energy experts. The experts, as a group, have devoted much time to this project; their personal commitment to energy conservation and renewable energy technology is impressive, and they are most willing to communicate their knowledge to teachers. I hope we can match their professional commitment.

Please give me a call at 603-352-1909 Ext. 295 if you have questions about the survey. I genuinely appreciate your assistance with this project.

Sincerely,

Richard L. Foley
Instructor, Industrial Education and Technology

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

September 24, 1984

Dear

Two weeks ago you were asked to respond to a questionnaire involving renewable energy technology and industrial arts education. This survey is the critical last step of a project to determine what New Hampshire's industrial arts teachers need to know in order to teach renewable energy education.

As a teacher of future industrial arts teachers, I am responsible for updating our programs at Keene State to reflect the revised state standards that have included energy conservation and alternative energy in the traditional power and energy cluster. This project should not only assist in the preparation of new teachers, but it will also provide information to all of us about what kinds of in-service workshops should be made available. At this point, renewable energy topics appear in all three clusters--power and energy, materials processing (especially construction), and communication (architectural drafting).

Lastly, as a former public school teacher, I can appreciate your busy schedule during the first few hectic weeks back at school. I do hope you can find a spare thirty minutes or so during this week to complete the data sheet and questionnaire. The list looks imposing, but the scoring system of checks and circles goes quickly. Approximately one half of your colleagues have responded, and they have stayed within the projected time limit.

Again, I look forward to your response, and I thank you in advance for your assistance with this project.

Sincerely,

Richard L. Foley
Industrial Education and Technology

P.S. Please feel free to call me at 603-352-1909, ext. 295, if you have any questions or comments.

Section I: Teacher Data Sheet

How would you describe your school? (Check as many categories as appropriate.)

____ rural	____ junior - senior high
____ urban	____ K - 12
____ junior high	____ private
____ senior high	____ hospital

What subject(s) have you taught this year? (Check as many categories as appropriate.)

	Prime area of responsibility JR. HIGH	Prime area of responsibility SR. HIGH	Secondary area of responsibility JR. HIGH	Secondary area of responsibility SR. HIGH
general shop	____	____	____	____
woodworking	____	____	____	____
drafting	____	____	____	____
electricity-electronics	____	____	____	____
general metals	____	____	____	____
power and energy	____	____	____	____
small engines or automechanics	____	____	____	____
plastics	____	____	____	____
machine shop	____	____	____	____
graphic arts	____	____	____	____
welding	____	____	____	____
math	____	____	____	____
science	____	____	____	____
other subject(s) (please list)	____	____	____	____
	____	____	____	____
administrative role(s) (title)	____	____	____	____

How many years have you been teaching (count this year!)?

____ total number of years
____ total number of years teaching industrial arts
____ number of years in your present school

Please indicate your age.

20-25	____	26-30	____	31-35	____	36-40	____	41-45	____
46-50	____	51-55	____	55-60	____	61+	____		

What did your professional preparation include (check all appropriate categories)	Indicate the College's name for each category.
____ teaching certificate in industrial arts	
____ teaching certificate(s) other than industrial arts (please list)	____
____ college-level coursework, but no degree	____
____ bachelor's degree in industrial arts	____
____ bachelor's degree in a major other than industrial arts	____ major: ____
____ bachelor's + 15 hours	____
____ master's degree	____
____ master's + 15 hours	____
____ master's + 30 hours	____
____ EdD or PhD	____

When was the last time you took a course for college credit?

_____ this year (83-84)
_____ last year (82-83)
_____ 2 years ago (81-82)
_____ 3 years ago (80-81)
_____ 4 or more years ago

When was the last time you took an in-service course or workshop (no college credit) in an industrial arts topic?

_____ this year (83-84)
_____ last year (82-83)
_____ 2 years ago (81-82)
_____ 3 years ago (80-81)
_____ 4 or more years ago

Have you taken a college-level course that included renewable energy topics?

no _____ 1 or 2 _____ 3 or 4 _____ more than 4 _____

Have you taken in-service course(s)/workshop(s) that dealt with renewable energy topics?

no _____ 1 or 2 _____ 3 or 4 _____ more than 4 _____

What has been your involvement in professional organizations (check those categories that currently apply or have applied in the last five years)?

	membership	office	committee work	formal presentations	regularly attend meetings, conventions, etc.
AIAA	_____	_____	_____	_____	_____
AVA	_____	_____	_____	_____	_____
NEIAA	_____	_____	_____	_____	_____
NHIEA	_____	_____	_____	_____	_____
NHVEA	_____	_____	_____	_____	_____
NHSEA	_____	_____	_____	_____	_____
NESEA	_____	_____	_____	_____	_____
other (________)	_____	_____	_____	_____	_____

Would you attend in-service workshops in renewable energy education topics next year?
yes _____ no _____

List the names of five of your industrial arts colleagues from whom you would prefer to receive in-service training in renewable energy education. Assume that those five teachers would have received technical updating from energy experts.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________

Would you like to receive a summary of the results of this study in renewable energy education?
yes _____ no

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

August 24, 1984

Dear

I need your help in bringing renewable energy education into the public schools of New Hampshire.

As an instructor at Keene State College, I am responsible for the training of industrial arts ("shop") teachers in the area of power and energy. Although the national focus on energy issues may have faded during the past decade, New Hampshire's teachers and leaders in industrial arts have been attempting to promote renewable energy education. Teachers have continued to list renewable energy topics as a top area for technical updating; the state guidelines for teaching industrial arts now recognize energy conservation and alternative energy as content areas; the revised State's standards for high school education has singled out "power and energy" industrial arts programs as a top priority.

In order for industrial arts teachers to introduce renewable energy education into the public schools, we must find out what the "experts" would define as renewable energy technology. During the past four months, leaders in the area of renewable energy have responded to a request to help identify experts in energy conservation and renewable energy--people who are oriented to practices appropriate to New Hampshire, have exhibited technical expertise in their field, and have the ability to communicate their knowledge. From a list of nearly three hundred names, approximately ninety individuals have received substantial peer support. Your colleagues have nominated you as a renewable energy expert!

I need your help then in identifying what industrial arts teachers need to know in order to teach renewable energy education. The enclosed survey represents the considerable efforts of 32 "experts" and teachers. Please read the directions carefully: you will simply be making check marks and circles. (This task should not take you more than half an hour. It probably would be easier to do it now, than to put it off.)

There is also a brief data form to help me recognize your area of expertise. Please indicate on this form if you would like to receive a summary of this study's results and if you would consider sharing your expertise with industrial arts teachers.

Please give me a call at 603-352-1909 Ext. 295 if you have questions about the survey. I genuinely appreciate your assistance with this project.

Sincerely,

Richard Foley
Instructor, Industrial Education and Technolocy

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

August 20, 1984

<N>

Dear <S>:

Enclosed is our last survey of the study on renewable energy education. I use the word "our", because you have supplied a number of comments that appear on this survey, and you have helped identify nearly one hundred renewable energy "experts" who will receive the survey.

The survey itself is a comprehensive list of what industrial arts teachers need to know in order to teach renewable energy education. The original list of definitions, produced by a small group of energy experts and industrial arts teachers (32 individuals), added up to approximately 1400 statements. My job was to identify discrete needs statements and organize the list--a process that produced a 496 item list. By answering this survey, your group of energy experts will rank these identified needs. The selection of topics and consulting services for the technical updating of industrial arts teachers requires that critically important knowledge areas be distinguished from optional ones.

The enclosed survey represents half that 496-item list to make your job easier. Please read the survey directions carefully. You will simply be making check marks and circles. This task should not take you more than half an hour. It probably would be easier to do it now, than to put it off.

There is also a brief data form to help me identify your area of expertise. Please indicate on this form if you would like to receive a summary of this study's results. And also indicate if you would consider sharing your expertise with industrial arts teachers. The next major step in bringing renewable energy education into the public schools of New Hampshire is straight forward: we need energy experts to work directly with a select group of teacher to provide them with the knowledge and skills as defined by our survey.

In closing, I thank you for your assistance with this project. If you have questions or comments about the survey in particular, or the project in general, please give me a call at 603-352-1909 Ext. 295. I genuinely appreciate your help.

Sincerely,

Richard L. Foley
Instructor, Industrial Education and Technology

EXPERT DATA SHEET

How would you describe your business or organization? (Check as many categories as appropriate.)

____ architectural firm

____ engineering firm

____ manufacturing firm

____ industrial/commercial construction

____ residential construction

____ distributor

____ wholesale outlet

____ retail outlet

____ college/university

____ non-profit agency

____ other (please describe)

How would you describe your role? (Check as many categories as appropriate.)

____ architect

____ engineer

____ contractor

____ consultant

____ owner/manager

____ technician

____ salesman

____ home builder

____ educator

____ director

____ researcher

____ consultant

____ other (please describe)

What are your areas of expertise in terms of energy conservation and renewable energy technology. (Check as many categories as appropriate.)

____ energy conservation (commercial/industrial)

____ energy conservation (residential)

____ passive solar (space heating/cooling)

____ active solar (space heating/cooling)

____ HVAC

____ DHW (active)

____ DHW (passive)

____ air: air heat exchangers

____ solid-fuel technology (stoves, boilers, etc.)

____ agricultural/industrial process heating

____ cogeneration

____ photovoltaics

____ windpower

____ hydropower

____ biomass

____ renewables in general

Would you like to receive a summary of this project's report?
yes ____ no ____

Would you be interested in working with industrial arts teachers?
yes ____ no ____

RENEWABLE ENERGY SURVEY

Definition of Industrial Arts

Industrial arts is the segment of general education that deals with industry—its organization, materials, occupations, processes, and products and the problems resulting from the industrial and technological nature of society. The majority of "shop" courses are offered in traditional areas such as woodworking, drafting, metals, small engine repair, consumer automechanics, graphic arts, machine shop, electricity/electronics, plastics, and general lab. Some schools are introducing broader-based courses in material processing, visual communication, and power and energy.

Survey Directions

Imagine that all of New Hampshire's industrial arts teachers are providing instruction in renewable energy education. Furthermore, their efforts are contributing to a comprehensive, kindergarten through twelfth grade program in energy conservation and renewable energy education that is operating successfully in the State's public schools. Given this scenario, imagine further that the State's more than 300 industrial arts teachers are successfully presenting concepts and developing lab activities that are helping students in both junior and senior high school programs to learn about energy use, conservation, and renewable energy sources.

As you think about what would be successful efforts, read each item in the list that follows. If the item refers to information that industrial arts teachers would need in order to teach renewable energy education, place a check mark in the space provided. Check as many items as you wish. Then, after completing the checking of needed items, go back over the list and circle the numbers of the twenty-five most important needs.

To assist you in this task, the items are organized under these headings:

I. BASIC ENERGY INFORMATION: SCIENTIFIC BACKGROUND
II. BASIC ENERGY INFORMATION: IMPLICATIONS
III. CONSERVATION AND RENEWABLE ENERGY: OVERVIEW
IV. CONSERVATION AND PRACTICE
V. THERMAL APPLICATIONS
   A. HEATING AND COOLING
   B. HEATING OF WATER
   C. WOOD-BURNING TECHNOLOGY
VI. SOLAR ELECTRIC
   A. PHOTOVOLTAICS
   B. WINDPOWER
   C. HYDROPOWER
VII. BIOMASS
VIII. DELIVERY OF RENEWABLE ENERGY EDUCATION IN INDUSTRIAL ARTS

GOOD LUCK WITH THE CHECKS AND CIRCLES!

I. Basic Energy Information: Scientific Background

___ 1. The definitions of energy in scientific terms.

___ 2. The law of energy conservation, including hands-on problem-solving.

___ 3. Kinetic and potential energy.

___ 4. How energy is transformed in scientific terms.

___ 5. How compact can energy be—compare potential energy, chemical energy etc.

6. Types of energy and energy storage alternatives.

___ 7. Power cycles, including Rankine, Otto, Diesel, Stirling, etc.

___ 8. How heat is measured.

___ 9. How much heat human beings give out, and how they give it out.

___ 10. The fundamentals of heat engines (including internal combustion and external combustion, turbines, refrigeration systems).

___ 11. BTU content and conversion efficiencies of various fuels.

___ 12. Electricity and electronics fundamentals.

___ 13. Design of small-scale electrical generators.

___ 14. Conversions of electrical energy.

___ 15. Heat storage, including storage devices and needs, thermal mass, etc.

___ 16. Fluid storage of energy, e.g., dams, reservoirs, etc.

___ 17. Mechanical storage of electricity including springs, flywheels, etc.

___ 18. Mechanical transmission of energy including lever, pulley, wheel and axle, screw, inclined plane, gears, etc.

___ 19. Electrical transmission and distribution, including synchronization utility distribution/interface, motors and generator, photovoltaics, controls, etc.

___ 20. The applied chemistry of the heat of combustion, including molecular structures of matter, phase changes, chemistry of combustion, air pollution, trace chemical analysis, etc.

___ 21. Basic physics.

___ 22. Statistics, including surveys.

___ 23. Geography (a basic knowledge).

___ 24. Forestry (a basic knowledge).

___ 25. Meterology (a basic knowledge).

___ 26. An understanding—conceptual and mathematical—of the science of energy.

___ 27. Basic knowledge of biology.

___ 28. Materials in relation to energy, including thermal, physical (e.g., corrosion), optical, insulative properties.

___ 29. The electromagnetic spectrum.

___ 30. Measurement of solar energy with a pyrometer.

II. Basic Energy Information: Implications

___ 31. Historical overview of all energy sources, supplies and demands in order to understand the validity of the energy crisis on a worldwide basis (e.g.: Hubbert's Law, exponential growth, availability of purchased energy, projections.

___ 32. What the most common forms of purchased energy are, their typical uses and costs.

___ 33. Understanding and appreciation of all sources of energy.

___ 34. What is the energy cost of producing material goods and services.

___ 35. The relationship between industrial development and energy supplies/ demands.

___ 36. Engineering economics or how to calculate return on investment.

___ 37. The cost effectiveness of different types of energy sources (non-renewable and renewable).

___ 38. Politics of energy use and distribution.

___ 39. The relationships between changing life styles and non-renewable and renewable energy supplies/demands.

___ 40. Information and news on pollution and pollution control.

___ 41. Small and large scale ramifications for utilizing each renewable energy source.

___ 42. Views of the larger picture: energy is intertwined with social, political, economic, cultural, environmental issues.

___ 43. How energy delivery systems, especially utilities, operate, including power rate structures, consumer interaction with delivery systems, consumer input into utility regulation.

___ 44. Future energy production systems.

___ 45. Ecology and its makeup.

___ 46. Environmental survey.

___ 47. Factors related to the difference in rural versus urban energy utilization.

___ 48. Awareness of various scenarios based upon a variety of energy sources and applications.

III. Conservation and Renewable Energy: Overview

___ 49. Renewable energy's role in the revival of "older" forms of technology, the revision of existing technologies, and the emergence of new technologies.

___ 50. Understanding and appreciation of the role of energy conservation in the scheme of helping to balance our nation's energy needs with the available resources.

___ 51. The impact of renewable energy or regional industries (e.g., recreation).

___ 52. Emphasis should be on practical, economically justifiable, and commercially available systems in conservation/ renewables that can be installed in homes and small businesses now.

___ 53. The economic impact of energy conservation and renewable energy.

___ 54. Appreciation of the true value of conservation, i.e., more cost-effective than producing new forms of energy.

___ 55. Strengths and weaknesses of federal and state legislation with regard to energy conservation and renewable energy.

___ 56. The political impact of energy conservation and renewable energy.

___ 57. Is the use of renewable energy mainly: fun for people with leisure and money, for the poorest people, for the richest people, for individuals living on remote farms, for New Yorkers living in skyscrapers, for General Motors, for the United States, for African countries?

___ 58. Overall environmental advantages and disadvantages of conservation/renewables compared to coal/oil/nuclear systems.

___ 59. Renewable energy sources, as opposed to "generated" energies, redistribute energy flows with the least effect on the earth's thermal equilibrium (global application of the first law of thermodynamics).

___ 60. The energy resources of New Hampshire, including renewable sources compared to the state's importation of energy.

___ 61. The energy impact of the crucial and complex set of issues that involve agriculture, waste disposal, water supply, recycling, sewage treatment, etc.

___ 62. All the reasons to conserve energy.

___ 63. Realization that the term "solar" should not be over utlized as the possible solution to all our energy needs.

___ 64. Daylighting as a renewable energy source.

IV. Conservation in Practice

___ 65. Ways to conserve energy.

___ 66. Concepts of efficiency (collection efficiency, conversion efficiency, seasonal efficiency).

___ 67. Cost/benefit factors and energy savings.

___ 68. How to evaluate appliance usage and to purchase energy-efficient appliances.

___ 69. Calculations of rates of return and/or pay back period for different energy system decisions (e.g., compare electric water heaters, solar water heaters, conservation measures).

___ 70. How individual and business tax credits affect energy costs.

___ 71. Conservation for hot water, including setpoint, extra insulation for tanks, pipe insulation, low-flow devices, greywater heat recovery, pressure reducing valves, timers, heat traps, tuning existing systems, etc..

___ 72. How to replace electrical energy use with more efficient types of energy.

___ 73. Energy conservation in the home.

___ 74. Energy loss through convection.

___ 75. Preventing energy loss.

___ 76. Repairing and adjusting appliances to reduce energy loss.

___ 77. Home decorating for energy conservation.

___ 78. Conservation measures for existing homes, including caulking, foaming, weatherstripping, adding insulation, etc..

___ 79. Passive solar designs for home retrofitting and space heating (including south windows, greenhouses/sunspaces, Trombe walls, heat storage).

___ 80. Industrial and agricultural energy conservation.

___ 81. Exposure to a large number of efficient and realistic conservation measures applicable to the state.

___ 82. How to do an energy audit analysis, including peak and annual heat loss, percentage of heat loss due to conduction, radiation, infiltration/exfiltration, etc..

___ 83. Infiltration heat loss calculations using door blowers, various measurement devices.

V. Thermal Applications

A. Heating and cooling of buildings

___ 84. Understanding of general solar calculation methods.

___ 85. Basic understanding of home heating and cooling systems, especially with regard to their use in highly insulated buildings.

___ 86. State-of-the-art knowledge about measurement and instrumentation, including thermal conductivity, air change rate (using blower-door and other methods), chemical analyses of air samples, temperature swings in spaces, fuel use, etc.

___ 87. Cost-effective strategies for northern New England, i.e., conservation (insulation, etc.) take precedence over solar devices.

___ 88. Building energy design tools, from manual methods to computer models.

___ 89. Daylighting behavior and methods.

___ 90. Visual comfort (glare reduction).

___ 91. Knowledge of the macroclimate of the state (including solar radiation, heating degree days, prevailing winds, etc.).

___ 92. Sun angle design and shade considerations in building design.

___ 93. Experience calculating building heat load calculations, including heat loss, internal/ intrinsic heat gains.

___ 94. Understanding of building materials and relative cost-effectiveness.

___ 95. Individual system safety requirements, including a good understanding of appropriate building codes (e.g., woodstove installation/maintenance, overhead glazing, etc.).

___ 96. Physical modeling of daylight designs.

___ 97. Proper flat roof design and fabrication using new high-R techniques.

___ 98. Daylighting implications in commercial buildings.

___ 99. New, high-efficiency artificial lighting approaches for commercial/ office spaces.

___ 100. Post-construction evaluation of building energy design impacts: heating and cooling, lighting, functionality, comfort, economics, environmental impact.

___ 101. Use and design of passive solar energy systems in house construction for space heating and cooling; e.g., thermal comfort, site analysis, building form and orientation, building envelope strategies, ventilation, shading, vegetation, construction.

___ 102. The role of "thermal mass" in heating and cooling buildings, e.g., materials, (rocks, masonry, water, phase change), properties, and behaviors.

___ 103. Types of materials for heat storage (active and passive systems).

___ 104. Mass wall (Trombe, water, etc.) fundamentals; e.g., what is it and how does it work; time delay and thickness, optimum storage to aperature ratio; phase change walls; vented versus unvented; night insulation techniques.

___ 105. Different generic types of passive solar heating/cooling systems and building types.

___ 106. Effect of combined insulation and mass.

___ 107. Dehumidification for natural-connection cooling systems.

___ 108. Different types of solar collectors.

___ 109. Effect of seasonal changes on solar collectors.

___ 110. Active solar systems for space heating and cost-effective comparisons.

___ 111. Practical experience measuring and evaluating the performance/ efficiency of different kinds of solar collectors.

___ 112. Overview of heating systems for buildings.

___ 113. Design concepts of forced ventilation systems.

___ 114. Testing and evaluation methods for ventilation systems.

___ 115. Energy distribution in HVAC (heating, ventilation, air conditioning), e.g., piping, plumbing, ductwork.

___ 116. HVAC (heat, ventilation, air conditioning) as part of the overall building operation.

___ 117. When to use heat pumps, particularly groundwater heat pumps.

___ 118. Heat pumps, including their function, design, operation; air, water, ground sources; sample projects and systems, etc.

___ 119. Complete understanding of R-factors, U-value, k, C.

___ 120. What superinsulation is.

___ 121. The issue of vapor barriers.

___ 122. Theories and applications for air/vapor barriers.

___ 123. Glazing performance, including types, heat gain/loss calculations, night-time insulation options.

___ 124. Shading methods for minimizing solar gains in offices including new heat rejecting/high daylight transmission windows.

___ 125. Importance of thermal breaks and sash construction in glazing systems.

___ 126. Importance of mounting seals in glazing systems.

___ 127. Characterization of indoor air pollutants—types and acceptable levels.

___ 128. Choice of materials/techniques to minimize pollution sources.

___ 129. Integration of ventilation into overall environmental control system.

___ 130. Use of air-to-air heat exchangers, including applications, sizing, etc.

___ 131. Indoor pollution from different systems (including types of pollutants, possible health effects, need for proper ventilation).

___ 132. Solar greenhouse design.

___ 133. Sunspace fundamentals, e.g., what is it and how does it work; orientation; minimum temperatures effect on performance; connecting wall as impact on temperature swing and performance; problems in connecting to living space; impact of mass on temperature and on annual performance.

___ 134. Commercial solar greenhouse.

___ 135. Knowledge of what can be grown at what seasons in a greenhouse?

___ 136. Some understanding of the needs of plants—temperature, humidity, light, etc.—in order to devise usable solar greenhouses as agricultural tools rather than life-style improvements.

___ 137. Comparison of fresh produce versus "storebought".

___ 138. Knowledge about weather stripping products and sealants for building envelope including materials and installation techniques.

___ 139. Skills in using a microcomputer.

___ 140. Knowledge of retrofit technology and materials for existing structures (residentail and commercial).

___ 141. Basic understanding of construction techniques.

___ 142. How to plot the sun.

___ 143. A rating system/monitoring methods for energy efficiency and consumption for existing homes and buildings.

___ 144. Use of micro-processors as tools for energy management.

___ 145. Air: air heat exchangers and their function and design.

B. Heating of Water

___ 146. Heating of water or SDHW (solar domestic hot water).

___ 147. Uses of heated water.

___ 148. Conservation measures for hot water, including, conservation, low-flow devices, low-temperature settings, cold wash, boosters for dishwashers, etc..

___ 149. Proper building design to facilitate solar (passive and active) and wood-fired hot water systems.

___ 150. Solar water heating projects and systems, including passive and active systems; site-built collectors, manufactured collectors; drain-down, closed-loop designs, etc..

___ 151. Calculations of thermal aspects of solar collectors, including performance, seasonal efficiency, storage, etc.

___ 152. Coupling solar with other devices, including conventional hot water heaters, on-demand heaters, wood-fired water heaters.

___ 153. Assess existing building for solar domestic hot water in terms of appropriate design, estimated cost and economic return.

___ 154. Hands-on experience with passive solar water heater installations, including plumbing, controls, collector sizing, roof penetrations, etc..

C. Wood-burning Technology (space-heating, agricultural and industrial process heating).

___ 155. Pro's and con's of burning wood for space heating.

___ 156. Basics of woodstoves and furnaces (choice, size, design and operation, heat content of wood).

___ 157. Use of wood for space heating.

___ 158. Catalytic converters for wood stoves.

___ 159. Agricultural and industrial process heating appropriate to New Hampshire, e.g., dairy farming.

___ 160. Applications of agricultural and industrial process heating.

___ 161. Readily available fuel sources, including industrial waste products (e.g., auto tires, scrap plastic, wood by-products).

___ 162. Thermal ponds.

VI. Solar Electric

A. Photovoltaics

___ 163. Definitions of terms used in photovoltaics work.

___ 164. General understanding of the construction of PV modules, including encapsulation techniques, use of diodes, frame and mounting techniques, etc..

___ 165. Possible, practical methods of reducing household electrical loads; e.g., straight conservation, energy-efficient appliances, DC-powered lights and appliances, gas-fired appliances, etc..

___ 166. Site considerations (indlucing average daily isolation, latitude, temperature extremes and averages, etc.).

___ 167. Economics of photovoltaics versus conventional, nonrenewable sources (including comparison of $/kwhr produced cost basis, high-efficiency appliances, utility service installation and maintenance, assumed increase in utility rates, etc.).

___ 168. Typical installation and components for independent systems (including high-efficiency appliances, PV Modules/options, various support structures, charge controllers from basic to automatic, fused disconnect switches, battery bank with fuse, different types of batteries, back-up generators, different types and characteristics of DC-to-AC inverters, etc.).

___ 169. New National Electric Code regulations for 12 V-DC systems (PV and wind power).

___ 170. Concentrators for PV systems.

___ 171. Four basic types of silicon cells in production (single crystal-cut wafers; single crystal-drawn ribbon; polycrystal-cost silicon; amorphores) and advanced technologies.

___ 172. Disadvantages of photovoltaics; including cost comparison with utility-produced electricity, etc..

___ 173. State-of-the are PV production techniques developments in storage batteries for PV/wind systems.

B. Windpower

___ 174. The how's and why's of windpower.

___ 175. Availability and quality (energy content and potential) of wind as a power source.

___ 176. An overview of residential and industrial applications and technology (including DC independent, AC/DC utility-interface, mechanical).

___ 177. Advantages of wind generators (including reliability, maintenance schedule, expected lye, limited pollution, modest energy debt, balanced output versus load, etc.).

___ 178. Theory of airfoils.

___ 179. Regional and local availability of wind power.

___ 180. Present and future economics of windpower.

___ 181. Typical installation and components of independent systems (including high efficiency appliances, wind generator and tower, lighting arestors, charge controller, disconnect- fused-switch, battery bank, inverter/converter, back-up generator, etc.).

___ 182. Typical installation and components of mechanical (water-pumping) system (including windmill, tower, left cylinder, force cylinder, left rod, water tank, etc.).

___ 183. How to do an actual wind survey.

___ 184. Methods of testing a windmill, including recording data and use of various monitors/sensors.

C. Hydropower

___ 185. Hydropower, principles of operation, basics of power production.

___ 186. Calculating hydropower output, including flow and head determinations, flow duration curves.

___ 187. Different types of turbines and their applications.

___ 188. Component efficiency for hydro installations.

___ 189. Calculating costs of hydro installations.

___ 190. Local, regard, state, and federal water laws and procedures for developing hydro sites.

___ 191. Topology and how to get pertinent information from it.

___ 192. Surveying and map drawing.

___ 193. Review the various disciplines needed to bring a project on line; e.g., legal, financial, civil, mechanical, electrical, hydraulic, and power engineering.

___ 194. Piping fundamentals; e.g., friction losses, pressure rating, steel verses plastic, installation procedures, prices.

VII. Biomass

___ 195. Readily avialable fuel sources, including animal waste, garbage, grain products, wood/chips/pellets, bagasse, vegetable fibers, peat, sewage sludges, etc..

___ 196. Gasification.

___ 197. Collecting and converting the most effective biomass materials into useful forms.

___ 198. Ethanol fermentation and utilization.

___ 199. Methane conversion processes.

___ 200. The impact of biomass on other aspects of the economy.

___ 201. Economic considerations, including comparative costs of different conversion approaches, calculation of avoided costs for fate projections, calculation of investment returns, sources of funding (public and private), marketing principles, etc..

___ 202. Combustion methods of different biomass fuel types.

___ 203. Biomass technology including fuel processing and handling, conversion and combustion equipment, emission and ash disposal control equipment, etc..

___ 204. Regulation of biomass technology including energy legislation, regulators (PUC's, Federal Energy Regulatory Commission), energy incentive laws (PURPA, LEEPA, tax rulings), special interest groups (agriculture and forest protection sources), local/regional/industrial development groups.

VIII. Delivery of Renewable Energy Education in Industrial Arts

___ 205. Access to exemplary projects/curriculum.

___ 206. A progression of energy awareness activities starting in the elementary schools.

___ 207. A directory that would list teachers and what they have selected for course content in renewable energy.

___ 208. An ideal curriculum in renewable energy education that would act as a base and could be updated.

___ 209. Develop a program that emphasizes 1) overall concepts (the big picture), 2) general guidelines for design (rules of thumb), and 3) case histories (written or visited).

___ 210. Plans to construct teaching aids, simple/student projects, show-and-tell working models which demonstrate appropriate concepts.

___ 211. Different methods of measuring energy output so that one system can be compared to another system.

___ 212. Practical solutions for residential housing needs in terms of renewable energy.

___ 213. The practical versus theoretical applications of various renewable energy sources.

___ 214. Developing a wind-sail car as a student project, including design considerations, construction, tools, materials, testing, recording data, and providing feedback to students.

___ 215. Developing a CO_2 car as a student project, including design considerations (wind resistance), construction, wind tunnel testing, data recording, and feedback to students.

___ 216. Designs for student projects that save energy (eg. wood stoves, thermal shutters, etc.).

___ 217. Energy awareness with regard to technical operations, such as correct use of tools, equipment.

___ 218. How to set up a few photovoltaic cells to show their potential.

___ 219. Films/filmstrips on renewable energy sources.

___ 220. Integrate renewables and conservation into general skill development.

___ 221. Inexpensive experiments that can be conducted in the classroom.

___ 222. A listing of funding sources, grants, etc. that might be available for developing new programs in renewable energy.

___ 223. List of experts in the field willing to answer questions (hotlines).

___ 224. Appropriate courses, seminars, etc. held at colleges for teacher in-service, updating.

___ 225. Weather forecasting information.

___ 226. A centralized library from which teachers could borrow materials.

___ 227. Sources of statistics on energy, fuels, usages, costs, supplies, consumptions, etc.

___ 228. College-level summary coursework on conservation; solar heating and cooling; biomass processes; solar electric.

___ 229. College-level lab work in one of the four renewable energy technologies (conservation; heating and cooling; solar processes; solar electric) to develop working facility with equipment, use of test and measurement tools, construction of a meaningful experiment.

___ 230. A series of workshops on design, construction, and installation of a passive solar hot water system.

___ 231. First-hand knowledge of home-building (comparable to knowledge gained at commercial home-building schools).

___ 232. How to contribute technical and political support to legislators, government officials on issues of energy technology and economics.

___ 233. Practical exposure to "real world" applications.

___ 234. Teacher-initiated projects with students or community groups (eg. build solar hot water system for town library, insulate older people's house, etc.).

___ 235. Organize a solar component wholesale co-op for the sale and distribution of quality solar products.

___ 236. Sponsor contests for energy-saving ideas.

___ 237. Teachers should build their own reference library of leading renewable energy books.

___ 238. Experience and skill in implementing and testing all the technologies taken up in the curriculum.

___ 239. Teachers need to take an overview course on solar hot water systems.

___ 240. Teachers need to use a wide variety of resources to provide vital, up-to-date information for students.

___ 241. Actual construction of a "batch-heater"—a passive solar hot water heater.

___ 242. Basic use of computers, e.g., to monitor energy output.

___ 243. Knowledge gained in an energy auditoing course (e.g., certification course for utility- sponsored home/ business energy auditors.

___ 244. Planning meetings with peers.

___ 245. Make a list of the 100 most common electrical appliances and memorize their wattage and energy numbers.

___ 246. Write a report on energy usage versus lifestyle (600BC to 1984AD).

Now that you have completed checking off needed items, don't forget to go back over the list and circle the numbers of the twenty-five most important needs.

RENEWABLE ENERGY SURVEY

Definition of Industrial Arts

Industrial arts is the segment of general education that deals with industry—its organization, materials, occupations, processes, and products and the problems resulting from the industrial and technological nature of society. The majority of "shop" courses are offered in traditional areas such as woodworking, drafting, metals, small engine repair, consumer automechanics, graphic arts, machine shop, electricity/electronics, plastics, and general lab. Some schools are introducing broader-based courses in material processing, visual communication, and power and energy.

Survey Directions

Imagine that all of New Hampshire's industrial arts teachers are providing instruction in renewable energy education. Furthermore, their efforts are contributing to a comprehensive, kindergarten through twelfth grade program in energy conservation and renewable energy education that is operating successfully in the State's public schools. Given this scenario, imagine further that the State's more than 300 industrial arts teachers are successfully presenting concepts and developing lab activities that are helping students in both junior and senior high school programs to learn about energy use, conservation, and renewable energy sources.

As you think about what would be successful efforts, read each item in the list that follows. If the item refers to information that industrial arts teachers would need in order to teach renewable energy education, place a check mark in the space provided. Check as many items as you wish. Then, after completing the checking of needed items, go back over the list and circle the numbers of the twenty-five most important needs.

To assist you in this task, the items are organized under these headings:

I. BASIC ENERGY INFORMATION: SCIENTIFIC BACKGROUND
II. BASIC ENERGY INFORMATION: IMPLICATIONS
III. CONSERVATION AND RENEWABLE ENERGY: OVERVIEW
IV. CONSERVATION AND PRACTICE
V. THERMAL APPLICATIONS
   A. HEATING AND COOLING
   B. HEATING OF WATER
   C. WOOD-BURNING TECHNOLOGY
VI. SOLAR ELECTRIC
   A. PHOTOVOLTAICS
   B. WINDPOWER
   C. HYDROPOWER
VII. BIOMASS
VIII. DELIVERY OF RENEWABLE ENERGY EDUCATION IN INDUSTRIAL ARTS

GOOD LUCK WITH THE CHECKS AND CIRCLES!

I. Basic Energy Information: Scientific Background

___ 1. The properties of energy in scientific terms.

___ 2. Elements and applications of thermodynamics, including the first and second laws of thermodynamics.

___ 3. Units of energy measurement (eg. BTU, KWHr, ft-lbs, HP, Conversions, etc.).

___ 4. How human beings take in and give out energy.

___ 5. Comparisons between the chemical energy of different materials— wood, dynamite, nuclear energy, a neutron star or "black hole".

___ 6. The relationship between energy and power.

___ 7. The definition of heat.

___ 8. The relationship between heat and temperature.

___ 9. The equivalence of heat and work.

___ 10. The physics of heat transfer (radiation, conduction, and convection).

___ 11. The law of cooling.

___ 12. Fundamentals of electrical generation (AC/DC).

___ 13. An overview of energy conversion processes.

___ 14. How energy can be controlled—held fixed or released on demand.

___ 15. Chemical storage of electrical energy (batteries).

___ 16. Electrical storage, including types of electricity, (AC,DC), circuits, batteries.

___ 17. The transmission, distribution, or transportability of various energy sources.

___ 18. Transmission of energy through light.

___ 19. Fluid transmission of energy, including hydraulic and pneumatic transmission.

___ 20. The applied physics of solid state concepts (conductors and semi-conductors) to understanding photovoltaics.

___ 21. The applied biology of basic plant physiology, emphasizing growth rate, nutrients needs, soil chemistry, ecology.

___ 22. Basic chemistry.

___ 23. An understanding of botany in order to teach about fuels from biomass.

___ 24. Geology (a basic knowledge).

___ 25. Astronomy (a basic knowledge).

___ 26. College-level training in physics and science.

___ 27. Skills in solving problems numerically, including algebra, order of magnitude, and estimation.

___ 28. Facility and experience with math to analyze and quantify problem-solving.

___ 29. Principles of conservation of fuels.

___ 30. Radio wave properties, e.g., propagation.

___ 31. Solar isolation, including power and spectrum, concepts of reflection, absorption and transmission of e. m. radiation, implications for design.

II. Basic Energy Information: Implications

___ 32. Basic history of energy sources and their uses, including efficiencies, costs, environmental and political impact as sources and as end products.

___ 33. The usefulness of different forms and sources of energy.

___ 34. How we place a value on energy in its various forms.

___ 35. Energy consumption in the United States, current figures and projections.

___ 36. Cost-effectiveness versus mechanical efficiency.

___ 37. Economic principles involved with various issues, e.g. village vs. suburban living; natural lighting, long range economics, etc.

___ 38. A clear understanding of energy economics so that alternative solutions can be compared and realistic options explored, e.g., first year cost, first year savings, years to payback, rate of return, cost benefit ratio, life cycle cost.

___ 39. International energy control systems.

___ 40. The environmental impact of all energy sources.

___ 41. Environmental, health and safety issues involved in energy systems.

___ 42. Understanding that not all proposed "solutions" to the energy problems of the world are possible, accurate, efficient, realistic, or possible.

___ 43. Electric power generation and transmission.

___ 44. High-tech versus low-tech usage of energy.

___ 45. Agriculture and energy (food/energy issues).

___ 46. System analysis.

___ 47. The concept of single energy consuming systems utilizing a mix of energy sources.

___ 48. Assessment of the actual versus desired energy needs.

___ 49. Problems of producing new non-renewable and renewable energy sources (economic, social, environmental, etc.).

III. Conservation and Renewable Energy: Overview

___ 50. Definition of energy conservation.

___ 51. Solar history—a brief overview to show that there is a history of harnessing of the sun's energy.

___ 52. Recognize the cost-effectiveness of de-centralized as opposed to centralized energy production.

___ 53. General prices and cost analysis of installing new renewable systems.

___ 54. The cost of conservation and renewable energies is lower than conventional energies when the entire lifetime of the energy system and the entire national economy are considered.

___ 55. Lobbying activities on the state and federal level (Sierra Club, Appalachian Club, etc.).

___ 56. The social impact of energy conservation and renewable energy.

___ 57. Energy conservation does not imply discomfort; rather, conservation implies encreased levels of comfort.

___ 58. The availability of regional renewable fuel sources (e.g., cordwood, woodchips, animal waste, garbage, industrial by-products).

___ 59. The comparision of different renewable energy sources in terms of gains and losses.

___ 60. Understanding that conservation generally does not have adverse side effects.

___ 61. The long range effects of energy conservation.

___ 62. Basics of solar energy, including availability, quality, climate dependent variables, the relationship between end use and efficiency.

IV. Conservation in Practice

___ 63. Energy saving equipment, technology, and trends.

___ 64. What the difference is between "convenience" and "efficient use" of energy sources.

___ 65. Conservation in relation to electric utility rates, including load management techniques, meter installations, peak demand, consumer habits, appliance rating.

___ 66. Some understanding of the micro-economics of home and commercial energy decision-making.

___ 67. Understand the effect of different interest rates and fuel cost inflation rates on the economics of different home/commercial systems.

___ 68. Conservation in lighting, including lumens, wattage of different sizes and types of lamps.

___ 69. What makes appliances (end-use) more efficient.

___ 70. Unwanted heat transfer, including building envelope losses (infiltration, conduction, effects of thermal mass).

___ 71. Energy loss through conduction.

___ 72. Energy loss through infiltration/exfiltration.

___ 73. Where and when to insulate.

___ 74. Infiltration heat loss calculations using door blowers/measurement devices.

___ 75. Retrofitting 1950 houses for energy available in the 1990's.

___ 76. Use of energy-efficient lighting systems.

___ 77. Conventional heating system efficiency improvements through control systems, improved design, better maintenance, etc.

___ 78. Transportation energy conservation.

___ 79. Organic gardening and its advantages, e.g., values of composting, water conservation, pesticide avoidance, increased harvests, etc.

___ 80. Calculation schemes for energy conservation; e.g., ASHRAE method.

___ 81. Window insulation, including commercial products, kits, homemade designs, etc.

V. Thermal Applications

A. Heating and Cooling

___ 82. Designing and constructing energy-efficient buildings (heating/cooling), including reducing square footage, maximizing space utilization, overhangs, etc..

___ 83. Building materials related to energy use and conservation.

___ 84. Principles of cooling.

___ 85. Recent fundamentals and on-going research on natural convection within highly insulated buildings.

___ 86. Practical information from the field on difficulties with new materials and devices, such as ridge venting, vapor barriers, double-wall construction, heat exchangers, special wiring runs, etc..

___ 87. Basics of solar radiation, including sunpaths versus time of day, season, etc.; true versus magnetic north; maximum power available.

___ 88. An understanding of and access to the growing number of computerized design tools for solar design, energy conservation analysis, lighting design, HVAC system design, etc..

___ 89. Solar radiation in terms of glazings, including heat losses versus transmissivity.

___ 90. Recognition that solar designs are based on the fact that solar energy is generally a low-grade heat source.

___ 91. Thermal comfort—how to measure it, what affects it.

___ 92. Understanding the climate of the region to take advantage of macroclimate and microclimate in building design and energy system installation.

___ 93. Knowledge of the microclimate (frost hollows, valley slope, lake and shore wind effects, shade and windbreak effects, wind direction and stack effect).

___ 94. Rules of thumb for attic and roof cavity ventilation.

___ 95. Superinsulation retrofitting options.

___ 96. Computer models of thermal and lighting behavior (application level, computer programming is optional).

___ 97. The relationship between glazing orientation and heating/cooling loads.

___ 98. Topography, including its relation to landscape architecture.

___ 99. Pre-construction identification of building energy design impacts; heating and cooling, lighting, functionality, comfort, economics, environmental impact.

___ 101. Daylighting behavior and methods.

___ 102. Envelope house construction.

___ 103. Earth-sheltered housing designs.

___ 104. Direct gain fundamentals in passive solar design, e.g., what is it and how does it work; performance versus glazing type in NE; importance of overheating controls (mass, aperature sizing); orientation versus performance, simple design patterns.

___ 105. Simple Balcomb performance evaluation methodology for passive solar design.

___ 106. Calculation of composite R-values.

___ 107. Rules of thumb for passive solar design.

___ 108. Earth tubes for cooling.

___ 109. Actual experience with passive solar design—especially sizing glazing, thermal mass, sun angles, etc..

___ 110. Site selection for solar collectors.

___ 111. Calculating angles for solar collectors.

___ 112. Solar collector fundamentals, e.g., different kinds—air, liquid, flat plate, concentrators; advantages and disadvantages; absorbers/coatings; transfer media; insulation options; glazings.

___ 113. Geo-thermal systems.

___ 114. Review of all types of heating systems, e.g., passive and active solar; resistance electric and radiant electric; efficient gas furnaces and oil furnaces; wood-burning stoves and boilers; air conditioners and heat pumps.

___ 115. Specifics of forced ventilation system design, e.g., fans, blowers, ducts, pressure drop balancing, etc..

___ 116. Moisture control in buildings (exhaust fans, etc.).

___ 117. Methods of deliberate heat transfer, including heat exchangers, collection, distribution, plumbing and ductwork.

___ 118. Natural ventilation techniques.

___ 119. Fundamentals of revising mechanical systems (HVAC) for energy-efficient buildings; e.g. equipment sizing for low equilibrium design loads, high efficiency motors, variable speed drives for pumps and fans, elimination of reheat and simultaneous heating/cooling; integrated thermal mass effects; first cost/operating cost trade-offs.

___ 120. Conventional heating systems, including how they work, cost/BTU, advantages, disadvantages, etc..

___ 121. Cost/benefits of superinsulation versus conventional insulation levels.

___ 122. Understanding and calculating dew points and condensation.

___ 123. Up-to-date information on air and vapor transmission in building construction.

___ 124. Up-to-date information on glazing technology, including issues of cost, durability, installation difficulties, public safety and codes, glazing structures, etc..

___ 125. Glazing systems available; options including double, triple, heat mirror, etc..

___ 126. Impact of glazing options on radiation comfort levels.

___ 127. Ventilation requirements for buildings—standards and calculation techniques.

___ 128. Design and construction to promote good ventilation.

___ 129. Continuing information on air quality in buildings, the use of air-to-air heat exchangers, the prevention of radon contamination, etc..

___ 130. Installation and maintenance of air-to-air heat exchangers.

___ 131. Types of greenhouses, conventional and solar.

___ 132. Sunspace systems for home owners, e.g., commercial/contractor; commercial kit, DIY (do-it-yourself).

___ 133. Moisture considerations in solar greenhouses.

___ 134. Control of temperature swings, pests, humidity, etc..

___ 135. Growing food in greenhouses as an energy saver (e.g., transportation).

___ 136. Knowledge and hands-on experience with solar greenhouse/sunspace design and construction including proper sloped glazing installation.

___ 137. Knowledge and experience installing and testing energy-efficient wall systems (new construction and retrofit) including insulation options, vapor barriers, caulking techniques, double-studs, etc..

___ 138. Thorough, well-grounded skills in conventional carpentry, construction trades, plumbing trades, and electrical/electronics work.

___ 139. Knowledge of new building (residential and commercial) techniques and materials.

___ 140. Superinsulated building techniques and calculation of cost-effectiveness for various design options.

___ 141. Calculating infiltration using crack method, air change/hr., tracer gas methods, etc..

___ 142. "Quick-and-dirty" testing methods for determining thermal performance.

___ 143. Quantitative energy performance evaluation techniques, e.g., understanding and analyzing energy consumption records, monitoring with instruments (simple to complex), diagnostic techniques.

___ 144. Thorough grounding in the physics of heat transfer through walls under steady-state conditions.

___ 145. Superinsulation techniques, e.g., wall system options, roof system options, foundation options, window systems, residential and commercial applications.

___ 146. Up-to-date knowledge about available insulation materials, including issues of public safety, long term R-factors, moisture absorptivity, strength, UV sensitivity, and other properties of commercial insulations.

___ 147. Air: air heat exchangers and their function and design.

B. Heating of Water

___ 148. Batch solar hot water heater (passive, attic/ground level) design and construction.

___ 149. The relationship between water temperature and use.

___ 150. Proper angles for solar water heaters.

___ 151. How to size a system, including hot water need, calculations of energy to heat water, system output, F-chart design tool, economics.

___ 152. Fundamentals of hot water solar collectors, e.g., different types; advantages and disadvantages; absorbers/coatings, glazing, insulation, and media options.

___ 153. Manufacturing techniques for solar sollectors, e.g., roll-forming, extrusion, etc.

___ 154. Installation procedures for active and passive hot water systems.

___ 155. Plumbing hook-ups for solar domestic hot water.

___ 156. Hands-on experience with active solar water heater installations.

C. Wood-burning Technology (space-heating, agricultural and industrial process heating)

___ 157. Basic safety concerns with heating with wood.

___ 158. Knowledge of wood-burning techniques.

___ 159. Utilization of energy production by-products/waste.

___ 160. Projected needs and resources in agricultural and industrial process heating.

___ 161. Solar kilns and grain dryers.

___ 162. Cogeneration.

VI. Solar Electric

A. Photovoltaics

___ 163. Basic principles of direct conversion of sunlight to electricity using semi-conductors/silicon-based solar cells.

___ 164. Various applications of photovoltaics (including remote homes, radio and telephone repeaters, boats, recreational vehicles, cathodic protection for remote pipilines and bridges, railroad crossings, portable DC powered equipment, utility interconnected power source, etc.).

___ 165. Costs of PV systems.

___ 166. Sizing independent and utility-interconnected photo voltaic (including calculations of daily power consumption in watt hours, average solar potential, required power output of the photovoltaic array, number of PV modules, utility payback schedule, etc.).

___ 167. Thorough grounding in the use of intermittent DC power from PV and wind devices, including battery storage, DC appliances, power inversion for connection to the AC grid, appropriate switch gear, and concerns of public utilities.

___ 168. Typical utility-interconnected installation and components including modules, support structures, lightning arrestor limits, source combiner units, synchronous inverters.

___ 169. Load Management considerations associated with small power producers.

___ 170. Combined thermal/electric systems (e.g. pV-supplied electricity to run DHW/solar system pumps and fans).

___ 171. Advantages of photovoltaics (including minimal maintenance, longevity, non-polluting, flexible for sites, small energy debt, etc.).

___ 172. Large scale governmental or utility installations.

___ 173. An in-depth program on photovoltaics.

B. Windpower

___ 174. Different types of windmills in terms of air foil/rotor design.

___ 175. Minimum windspeeds for reasonable yields.

___ 176. Definitions of terms in windmill work.

___ 177. Disadvantages of wind generators (including maintenance, visual and noise pollution, site specific limitation, etc.).

___ 178. Formulas for determining power output based on windspeed, rotor diameter, etc.

___ 179. Economics of windpower systems (including wind power output versus conventional, nonrenewable source, comparison of options based on $/KWHR produced cost basis, additional cost of high efficiency appliances, cost of utility interface installation and maintenance, general mintenance, tax incentives, etc.).

___ 180. Basic site considerations, including average wind speed at anticipated windmill height, turbulance, maximum wind speeds, min/max temperatures, soil conditions for tower base, etc.

___ 181. Typical installation and components of utility interconnected systems (including wind generator, tower, lightning arrestor, synchronous inventer, etc.).

___ 182. Sizing wind systems with considerations indluding wind potential, estimated load, windless periods, AC power required, payback scheme, etc.

___ 183. The construction of a windmill, including design, materials, and tools.

C. Hydropower

___ 184. Availability of water as a power source (including all forms from low-head hydro to gulf stream).

___ 185. Background information on microhydro systems (site requirements, available equipment, look-ups, utility interface, utility payback, etc.

___ 186. Generator theory; e.g., AC, DC, induction.

___ 187. Present and future economics of hydropower.

___ 188. The problems of using a public resource (water) for public or private gain.

___ 189. Hydrology; e.g., watersheds, drainage areas, general water, altitude, hydraulic lengths, soil compositions, etc.

___ 190. Types, constructors, and interpretations of weirs.

___ 191. Environmental impact and the general ecology of streams, brooks, etc.

___ 192. Electronic controls and interface equipment; e.g., simple voltage regulators, speed governors, load controllers.

___ 193. Building and design principles of dams.

VII. Biomass

___ 194. Basic information framework in biogas extraction from organic wastes, including biomass types, combustion theory, physical chemistry, biological conversion systems, gas extraction.

___ 195. Types of biomass having the most stored energy.

___ 196. Anaerobic digestion and utilization of biogas for fuel.

___ 197. Fermentation and distillation processes.

___ 198. Cost of different biomass fuel types.

___ 199. Economics of biomass power; from small scale (farm) to large scale (city).

___ 200. Gasification (producer gas generators).

___ 201. Familiarity with experimental biomass fuel use (eg. SD Warren co-generation, methane from fish waste, garbage).

___ 202. Design of energy interfaces - thermal, electric, mechanical, etc.

___ 203. Methanol chemistry.

VIII. Delivery of Renewable Energy Education in Industrial Arts

___ 204. Broad definition of renewable energy education including a listing of all areas that would be included in the definition.

___ 205. Location of teaching resources, including texts and software.

___ 206. Interdepartmental projects and activities.

___ 207. A syllabus of what should be covered in renewable energy education.

___ 208. Assistance with acquiring, reviewing and adapting existing energy-oriented curriculum materials to reflect New Hampshire's energy picture.

___ 209. Ways of demonstrating practical uses for renewable energy sources and conversion systems.

___ 210. Methods of introducing energy awareness on the secondary level.

___ 211. A variety of models of different energy systems.

___ 212. Developing a windmill as a student project, including design considerations, construction, tools, materials, testing methods, data recording, and feedback to students.

___ 213. Small engines as projects for teaching thermal efficiency, effects of maintenance and tune-ups, frictional losses, appropriate applications of energy converters.

___ 214. Ways of recycling lab materials/waste (eg. metal scraps, wood wastes).

___ 215. How to construct a "beer box" hot water heater, stressing insulation, absorption, glazing options, and tests for heat-up time, maximum temperature, and heat retention.

___ 216. A list of places to visit to see alternative energy systems being used (eg. hydro sites, agricultural/ industrial process heating, PV installation, component manufacturer, etc.).

___ 217. How to modify a small gas engine to run on methane produced by three cubic feet of organic waste material (manure, etc.).

___ 218. A motor kit that could be modified to run on various fuels.

___ 219. Methods for calculating and comparing efficiencies of conventional and alternative fuels.

___ 220. A simple standardized set of lab experiments in renewable energy that demonstrate meaningful concepts, require mathematical analysis, and relate to real world applications.

___ 221. To develop practical strategies for incorporating conservation and renewables into the school curriculum.

___ 222. Work directly on school buildings to improve their energy efficiency, e.g., energy audit, weatherization, moveable insulation, etc..

___ 223. How to obtain information from various sources (eg. libraries, foundations, industry).

___ 224. A listing of TV and radio shows providing more information on renewable energy.

___ 225. Pamphlets on alternative energy sources, heating and cooling systems.

___ 226. List of resources that could provide detailed information (eg. bibliographies, libraries), people, journals ("Solar Age", "New Shelter", "Fine Homebuilding", "Alternative Sources of Energy", "Northeast Sun", "New England Builder", etc.).

___ 227. Alternative energy newsletter to keep IA teachers informed of the latest happenings.

___ 228. A list of supply houses that sell components to build solar panels, etc..

___ 229. Sources for news of technical developments in renewable energy fields, including what the "cutting edge" practioners are doing.

___ 230. College-level in depth coursework on one of the four renewable energy technologies (conservation; heating and cooling; solar processes; solar electric) using analytical techniques and mathematical problem-solving.

___ 231. Speakers from industry and governmental/private agencies who would talk to students on renewable energy.

___ 232. An understanding of existing systems and evolving developments.

___ 233. Teachers must be kept abreast of important changes in the building industry, including industrialized building, building retrofitting, etc..

___ 234. Use of Energy Auditors Training Manual, prepared by D.O.E., UMASS Cooperative Extension Service (Amherst), and SERI.

___ 235. Be able to build a solar hot water heating system.

___ 236. Teacher-initiated study groups, seminars, energy-related series in the community/school as learning tools.

___ 237. Research and publish data on financial aid, tax incentives, grants, discounts for energy-conserving groups/individuals.

___ 238. Some knowledge about marketing and business management in renewable energy (adequate marketing of products and services by small companies).

___ 239. Experimentation with several conservation techniques.

___ 240. Teachers need to spend a day or two with a "weatherization" crew to familiarize themselves with materials and installation techniques.

___ 241. Teachers need to observe a blower-door test.

___ 242. Teachers are presumed to have gained the basic skills in planning and installation of electric, plumbing and ventilation systems and general building construction that would allow them to teach these skills effectively.

___ 243. The use of graphs in education.

___ 244. An overwhelming desire on the part of teachers to be concerned with energy conservation and alternative energy.

___ 245. Direct experience with conservation/renewable devices and techniques, both real things and models.

___ 246. Personally build a device that can generate one kilowatt hour from a renewable energy source.

___ 247. Prepare a viable scenario for our planet and people if all oil, coal, and nuclear materials were to disappear in 10 years.

___ 248. Be able to put together a PV module from components, or to design and install a small PV system.

Now that you have completed checking off needed items, don't forget to go back over the list and circle the numbers of the twenty-five most important needs.

APPENDIX H.

1. Thank-You Letter for Teachers

2. Thank-You Letter for Teachers After Follow-Up

3. Thank-You Letter for Experts

4. Teacher RES Survey Records

5. Nominations for Influential Teachers

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

September 25, 1984

<N>

Dear <S>:

Thank you! You did an excellent job of filling out the demographic sheet and the Renewable Energy Survey. It was quite a challenge, and I appreciate your effort.

You may have had the feeling that your response was not definitive or totally satisfying. However, your scoring will be added to the responses of 96 other renewable energy experts. The result of this bigger picture will be a priority rating of 496 items teachers need to know in order to teach renewable energy education. This list is a great piece of information for decision-making.

In fact, this project will compare the perceptions of the two groups of respondents--industrial arts teachers and the renewable energy experts. From this comparison, we should make some recommendations about the type of technical updating and/or teaching strategies that should be made available to industrial arts teachers and about the experts who should do the technical training.

A report with recommendations will be mailed later this fall.

Again, let me say thank you for a fine job. Over 90% of the experts have responded, and the teachers appear to be headed for a similar effort.

Sincerely,

Richard L. Foley
Industrial Education and
Technology Department

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

November 26, 1984

<N>

Dear <S>:

Thank you! You did an excellent job of filling out the demographic sheet and the Renewable Energy Survey. It was quite a challenge, and I appreciate your effort.

You may have had the feeling that your response was not definitive or totally satisfying. However, your scoring will be added to the responses of 325 other teachers. The result of this bigger picture will be a priority rating of 496 items teachers need to know in order to teach renewable energy education. This list is a great piece of information for decision-making.

In fact, this project will compare the perceptions of the two groups of respondents--industrial arts teachers and the renewable energy experts. From this comparison, we should make some recommendations about the type of technical updating and/or teaching strategies that should be made available to industrial arts teachers and about the experts who should do the technical training.

Again, let me say thank you for a fine job. Ninety-two percent of the experts had sent in their responses by October. At that time, only 33% of our State's industrial arts teachers had mailed in their responses. Thanks to you and your colleagues who answered the follow-up letter, the response rate for teachers jumped to 70%. This increase in information will make a real difference for this study.

A report with recommendations will be mailed later this winter.

Hope you enjoy the holiday season.

Sincerely,

Richard L. Foley
Industrial Education and
Technology Department

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

September 25, 1984

<N>

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Sincerely,

Richard L. Foley
Industrial Education and
Technology Department

TEACHER RES SURVEY
RECORDS

326	Positions listed 1983-1984 New Hampshire Industrial Arts Education Teacher Directory.
4	Part-time positions filled by two teachers. A) 005, 241 filled by James Sweeney B) 018, 094 filled by Ronald Reynolds
4	Positions unfilled as of November 1, 1984.
11	Positions eliminated. 030, 032, 043, 052, 111, 124, 143, 184, 294, 250, 267
309	Positions surveyed.
217	Responses by November 1, 1984 (RES Forms A and B)
70%	Response Rate (RES Forms A and B)
226	Responses by November 1, 1984 (Teacher Data Sheet)
73%	Response Rate (Teacher Data Sheet)

NOMINATIONS FOR INFLUENTIAL TEACHERS

ID Number	Nominating Teachers	Congruency Scores
Cheshire Vocational Center	117	
Cheshire Vocational Center	117	
Cheshire Vocational Center	117	
256	258	NA
257	258	.1769
259	258	.2137
265	258	.1750
128	258, 127	.3066
Keene State College	308, 008, 203, 097, 090, 129, 108	
Keene State College	308, 203, 097	
Keene State College	308, 097	
198	008, 203, 027, 260, 200	.2533
054	008	.1882
114	114	.0773
116	114	.1374
313	311, 312	.2453
312	311	.2051
NA	100	
NA	100, 101	
178	100	.3195
146	140, 142, 145	.0818
144	140, 142, 145, 146	.2848

ID Number	Nominating Teachers	Congruency Scores
NA	140	
042	140	.0921
101	101	.0875
100	101	.1070
NA	101	
NA	142, 145, 146	
145	142, 146	.1372
067	066	.2749
065	066	.3460
NA	041	
228	041	NA
140	145, 146	.4358
NA	145	
Timberland Jr. High School IA Teacher on Sabbatical	249	
253	249	.2770
008	249, 107	.3874
NA	249	
222	249	.2252
286	283	NA
287	283	.3932
284	283	.2421
282	283	NA
197	200, 203	NA

ID Number	Nominating Teachers	Congruency Scores
Former KSC IA Instructor	203	
249	248	.4047
130	127	NA
129	127	.3632
NA	127	
NA	127	
Conval H.S. Vocational Dir.	242	
NA	242	
NA	242	
026	027, 025	.2191
261	027, 260	.2302
024	027, 025	.2045
015	027	-.0103
029	025	.2787
027	025	.1797
NA	025	
001	002	.0950
186	185, 319	.3809
NA	185	
189	185	.0947
NA	165	
149	165	NA
158	165	.2027

ID Number	Nominating Teachers	Congruency Scores
154	165	.3387
147	165	NA
318	319	.4244
221	319	NA
Keene State College	129	
305	304	.3541
306	304	NA
307	304	.2712
308	304	.3002
283	304	.0697
KSC IA Graduate	107	
KSC IA Graduate	107	
NA	064	
062	064	.2290
NA	064	
NA	064	
NA	064	
296	297	.2894
Keene State College	108	
238	236	.1964
239	236	.2529
IA Teacher/Renewable Energy Expert from NY State	223, 260	
166	168	.2137

ID Number	Nominating Teachers	Congruency Scores
167	168	.3516
168	168	.0589
169	168	.0434
199	200	NA
200	200	.2910
201	200	NA
202	200	.2484
203	200	.4380
281	283	.4414

Comments	Respondents
A. Prefer in-service leadership from experts. 192, 018	2
B. Would accept in-service leadership from any qualified teacher or expert. 006, 056, 104, 009, 078, 187, 053, 074, 173	9
C. Do not know of any teacher they could recommend. 169, 010, 153, 210, 137, 270, 273, 158	8
D. No teachers know this field. 062, 017, 313, 284	4
E. No money will be available. 264	1
Total	24

APPENDIX I.

1. Analysis of Priority Rankings: Energy Experts and IA Teachers
2. Expert Priority List
3. Teacher Priority List

Analysis of Priority Rankings: Energy Experts and IA Teachers

Ranking by Experts	Ranking by Teachers	
		I. Basic Energy Information: Scientific Background
21.	28.	A. Energy and Power
7.		B. Heat Energy
		C. Energy Generation, Storage, Conversion, Distribution
22.		D. Science Support
		II. Basic Energy Information: Implications
5.9.	9.12.	A. History
	29.	B. Supply & Demand
1.		C. Economics
		D. Politics
		E. Social
29.		F. Environmental Concerns
28.		G. Specific Issues
		III. Conservation and Renewable Energy: Overview
18.		A. History
		B. Economics
		C. Politics
		D. Social
		E. Environmental
10.		F. Specific Issues
8.	26.	G. Science Support
		IV. Conservation in Practice
13.	3.17.	A. Definitions
		B. Economics
24.30.	13.21.22.	C. Residential/Commercial Buildings
		D. Transportation
		E. Industrial
		F. Agricultural
		G. Specific Issues
		V. Thermal Applications
		A. Heating and Cooling
3.12.17.25.	23.	1. Design
6.11.	30.	2. Passive
16.		3. Active
2.	4.	4. HVAC
20.		5. Insulation
		6. Vapor Barriers
		7. Glazings

Ranking by Experts	Ranking by Teachers	
		8. Air: Air Exchangers
		9. Sunspace/Greenhouse
		10. Construction Skills
		B. Heating of Water
23.		1. Design
		2. Passive
		3. Active
		4. HVAC
		5. Installation
		C. Wood-Burning Technology (space-heating, agricultural and industrial process heating)
	1.10.	1. Wood-burning technology
		2. Agricultural/industrial process heating
	VI.	Solar Electric
		A. Photovoltaics
15.	11.	1. Basics
		2. Economics
		3. Installation
		4. Specifics
		B. Windpower
27.	2.7.	1. Basics
		2. Economics
		3. Installation
		4. Specifics
		C. Hydropower
4.	5.27.	1. Basics
		2. Economics
		3. Installation
		4. Specifics
	VII.	Biomass
19.26.	8.	A. Basics
		B. Economics
		C. Installation
		D. Specifics
	VIII.	Delivery of Renewable Energy Education in Industrial Arts
14.	20.	A. Definitions
	6.15.19.24.	B. Curriculum
	16.25.	C. Direct Delivery Methods
	14.18.	D. Technical Support
		E. Teacher Skills

EXPERT PRIORITY LIST

Priority	Master List Number	RES A or B and Number
1	75	A - 38

A clear understanding of energy economics so that alternative solutions can be compared and realistic options explored, e.g., first year cost, first year savings, years to payback, rate of return, cost benefit ratio, life cycle cost.

2	228	A - 114

Review of all types of heating systems, e.g., passive and active solar; resistance electric and radiant electric; efficient gas furnaces; wood-burning stoves and boilers; air conditioners and heat pumps.

3	166	A - 82

Designing and constructing energy-efficient buildings (heating/cooling), including reducing square footage, maximizing space utilization, overhangs, etc..

4	369	B - 185

Hydropower, principles of operation, basics of power production.

5	64	B - 31

Historical overview of all energy sources, supplies and demands in order to understand the validity of the energy crisis on a worldwide basis (e.g.: Hubbert's Law, exponential growth, availability of purchased energy, projections).

6	208	A - 104

Direct gain fundamentals in passive solar design, e.g., what is it and how does it work; performance versus glazing type in NE; importance of overheating controls (mass, aperature sizing); orientation versus performance, simple design patterns.

7	21	A - 10

The physics of heat transfer (radiation, conduction, and convection).

8	124	A - 62

Basics of solar energy, including availability, quality, climate dependent variables, the relationship between end use and efficiency.

9	63	A - 32

Basic history of energy sources and their uses, including efficiencies, costs, environmental and political impact as sources and as end products.

Expert Priority List, continued

Priority	Master List Number	RES A or B and Number
10	121	B - 60

The energy resources of New Hampshire, including renewable sources compared to the State's importation of energy.

11	201	B - 101

Use and design of passive solar energy systems in house construction for space heating and cooling; e.g., thermal comfort, site analysis, building form and orientation, building envelope strategies, ventilation, shading, vegetation, construction.

12	176	A - 87

Basics of solar radiation, including sunpaths versus time of day, season, etc.; true versus magnetic north; maximum power available.

13	128	B - 65

Ways to conserve energy.

14	411	B - 206

A progression of energy awareness activities starting in the elementary schools.

15	325	A - 163

Basic principles of direct conversion of sunlight to electricity using semi-conductors/silicon-based solar cells.

16	224	A - 112

Solar collector fundamentals, e.g., different kinds--air, liquid, flat plate, concentrators; advantages and disadvantages; absorbers/ coatings; transfer media; isulation options; glazings.

17	169	B - 85

Basic understanding of home heating and cooling systems, especially with regard to their use in highly insulated buildings.

18	101	B - 50

Understanding and appreciation of the role of energy conservation in the scheme of helping to balance our nation's energy needs with the available resources.

19	389	B - 195

Readily available fuel sources, including animal waste, garbage, grain products, wood/chips/pellets, bagasse, vegetable fibers, peat, sewage sludges, etc..

20	237	B - 119

Complete understanding of R-factors, U-value, k,C.

Expert Priority List, continued

Priority	Master List Number	RES A or B and Number
21	3	A - 2

Elements and applications of thermodynamics, including the first and second laws of thermodynamics.

22	42	B - 21

Basic physics.

23	302	A - 152

Fundamentals of hot water solar collectors, e.g., different types; advantages and disadvantages; absorbers/coatings, glazing, insulation, and media options.

24	154	B - 78

Conservation measures for existing homes, including caulking, foaming, weatherstripping, adding insulation, etc..

25	174	A - 86

Practical information from the field on difficulties with new materials and devices, such as ridge venting, vapor barriers, double-wall construction, heat exchangers, special wiring runs, etc.

26	388	A - 194

Basic information framework in biogas extraction from organic wastes, including biomass types, combustion theory, physical chemistry, biological conversion systems, gas extraction.

27	347	B - 174

The how's and why's of windpower.

28	86	B - 42

Views of the larger picture: energy is intertwined with social, political, economic, cultural, environmental issues.

29	79	A - 40

The environmental impact of all energy sources.

30	143	A - 70

Unwanted heat transfer, including building envelope losses (infiltration, conduction, effects of thermal mass).

TEACHER PRIORITY LIST

Priority	Master List Number	RES A or B and Number
1	311	B - 155

Pro's and con's of burning wood for space heating.

2	347	B - 174

The how's and why's of windpower.

3	128	B - 65

Ways to conserve energy.

4	228	A - 114

Review of all types of heating systems, e.g., passive and active solar; resistance electric and radiant electric; efficient gas furnaces and oil furnaces; wood-burning stoves and boilers; air conditioners and heat pumps.

5	369	B - 185

Hydropower, principles of operation, basics of power production.

6	414	A - 207

A syllabus of what should be covered in renewable energy education.

7	348	A - 174

Different types of windmills in terms of air foil/rotor design.

8	389	B - 195

Readily available fuel sources, including animal waste, garbage, grain products, wood/chips/pellets, bagasse, vegetable fibers, peat, sewage sludges, etc..

9	63	A - 32

Basic history of energy sources and their uses, including efficiencies, costs, environmental and political impact as sources and as end products.

10	312	A - 157

Basic safety concerns with heating with wood.

11	325	A - 163

Basic principles of direct conversion of sunlight to electricity using semi-conductors/silicon-based solar cells.

Teacher Priority List, continued

Priority	Master List Number	RES A or B and Number
12	64	B - 31

Historical overview of all energy sources, supplies and demands in order to understand the validity of the energy crisis on a worldwide basis (e.g.: Hubbert's Law, exponential growth, availability of purchased energy, projections).

13	144	B - 73

Energy conservation in the home.

14	447	B - 224

Appropriate courses, seminars, etc. held at colleges for teacher in-service, updating.

15	410	A - 205

Location of teaching resources, including texts and software.

16	419	B - 210

Plans to construct teaching aids, simple/student projects, show-and-tell working models which demonstrate appropriate concepts.

17	129	A - 63

Energy saving equipment, technology, and trends.

18	452	A - 227

Alternative energy newsletter to keep IA teachers informed of the latest happenings.

19	409	B - 205

Access to exemplary projects/curriculum.

20	408	A - 204

Broad definition of renewable energy education including a listing of all areas that would be included in the definition.

21	153	A - 75

Retrofitting 1950 houses for energy available in the 1990's.

22	149	A - 73

Where and when to insulate.

23	169	B - 85

Basic understanding of home heating and cooling systems, especially with regard to their use in highly insulated buildings.

Teacher Priority List, continued

Priority	Master List Number	RES A or B and Number
24	415	B - 208

An ideal curriculum in renewable energy education that would act as a base and could be updated.

25	441	B - 221

Inexpensive experiments that can be conducted in the classroom.

26	124	A - 62

Basics of solar energy, including availability, quality, climate dependent variables, the relationship between end use and efficiency.

27	368	A - 184

Availability of water as a power source (including all forms from low-head hydro to gulf stream).

28	5	A - 3

Units of energy measurement (e.g., BTU, KWHr., ft-lbs, HP, conversions, etc.).

29	68	B - 33

Understanding and appreciation of all sources of energy.

30	201	B - 101

Use and design of passive solar energy systems in house construction for space heating and cooling; e.g., thermal comfort, site analysis, building form and orientation, building envelope strategies, ventilation, shading, vegetation, construction.

APPENDIX J.

1. SPSS-X Printout: Spearman's Rank Order Correlation Coeffiient

2. SPSS-X Printout: Spearman's Rank Order Correlation (tied ranks)

3. SPSS-X Printout: Pearson Correlation Coefficient

```
1  7-JAN-85     RANKS ORDERS GROUPS
2
 15:36:26       KEENE STATE COLLEGE        DEC VAX-11/780 VMS V3.6

0---S P E A R M A N   C O R R E L A T I O N   C O E F F I C I E N T S----
0
0
 TEACH              .6273

                 N(  493)

                 SIG .000


 0                 EXPERTS


 0" . "  IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.
 1  7-JAN-85     RANKS ORDERS GROUPS
 3
  15:36:26       KEENE STATE COLLEGE        DEC VAX-11/780 VMS V3.6

 OPRECEDING TASK REQUIRED      2.52 SECONDS CPU TIME;     3.98 SECONDS ELAPSED.


     17  0             FINISH
 0              17 COMMAND LINES READ.
                 0 ERRORS DETECTED.
                 0 WARNINGS ISSUED.
                 3 SECONDS CPU TIME.
                 6 SECONDS ELAPSED TIME.
                   END OF JOB.
```

```
1  4-JAN-85     RANKS ORDERS GROUPS
2
 16:17:10       KEENE STATE COLLEGE        DEC VAX-11/780 VMS V3.6

0---S P E A R M A N   C O R R E L A T I O N   C O E F F I C I E N T S---
0
0
 TEACH               .6269

                N(  493)

                SIG .000


0                EXPERTS


0" . "  IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.
1  4-JAN-85     RANKS ORDERS GROUPS
3
 16:17:11       KEENE STATE COLLEGE        DEC VAX-11/780 VMS V3.6


0PRECEDING TASK REQUIRED      2.81 SECONDS CPU TIME;     6.74 SECONDS ELAPSED.


   15  0             FINISH
0            15 COMMAND LINES READ.
              0 ERRORS DETECTED.
              0 WARNINGS ISSUED.
              4 SECONDS CPU TIME.
             10 SECONDS ELAPSED TIME.
                END OF JOB.
```

```
1 11-APR-85    PEARSON 4 11 85
5
 20:02:11      KEENE STATE COLLEGE        DEC VAX-11/780 VMS V3.6

0----P E A R S O N  C O R R E L A T I O N  C O E F F I C I E N T S----

 VARIABLE    VARIABLE    VARIABLE    VARIABLE    VARIABLE    VARIABLE

 PAIR        PAIR        PAIR        PAIR        PAIR        PAIR
 --------    --------    --------    --------    --------    --------

ONCM            .0374

 WITH          N( 200)
 CONGR         SIG  .299

0" . "  IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.
111-APR-85     PEARSON 4 11 85
6
 20:02:12      KEENE STATE COLLEGE        DEC VAX-11/780 VMS V3.6

OPRECEDING TASK REQUIRED     13.33 SECONDS CPU TIME;     20.71 SECONDS ELAPSED.

   26  0          FINISH
0           26 COMMAND LINES READ.
             0 ERRORS DETECTED.
             0 WARNINGS ISSUED.
            17 SECONDS CPU TIME.
            26 SECONDS ELAPSED TIME.
               END OF JOB.
```

APPENDIX K.

1. Teacher Data Sheet: Results

2. Teacher Demographic Data: Totals for Coded Variables

Teacher Data Sheet: Results

NC - Not run in the correlation
NB - Noted by addendum
VAR - Variable identification number

How would you describe your school? (Check as many categories as appropriate.)

81	rural	51	junior - senior high
55	urban	13	K - 12
64	junior high	4	private
75	senior high	3	hospital

What subject(s) have you taught this year? (Check as many categories as appropriate.)

	Prime area of responsibility		Secondary area of responsibility	
	JR. HIGH	SR. HIGH	JR. HIGH	SR. HIGH
general shop	28	13	3	1
woodworking	63	57	7	7
drafting	35	52	3	9
electricity-electronics	13	32	0/NC	2
general metals	27	28	6	3
power and energy	8	21	2	1
small engines or automechanics	19	38	2	5
plastics	16	4	2	1
machine shop	2	15	0/NC	2
graphic arts	13	14	3	1
welding	6	24	1	4
math	2	5	2	3
science	2	1	1	1
other subject(s) (please list)	14 VAR148/NB	20 VAR150/NB	1	1
administrative role(s) (title)	6 VAR147/NB	12 VAR149/NB	0/NA	1

How many years have you been teaching (count this year!)?

VAR071/NB total number of years
VAR072/NB total number of years teaching industrial arts
VAR073/NB number of years in your present school

Please indicate your age.
(0 - No response)

20-25	15	26-30	17	31-35	28	36-40	44	41-45	32
46-50	25	51-55	19	55-60	10	61+	7		

What did your professional preparation include (check all appropriate categories)		Indicate the College's name for each category.
117	teaching certificate in industrial arts	
38	teaching certificate(s) other than industrial arts (please list)	VAR077/NB
19	college-level coursework, but no degree	VAR079/NB
127	bachelor's degree in industrial arts	VAR081/NB
29	bachelor's degree in a major other than industrial arts	VAR083/NB major: VAR084/NB
44	bachelor's + 15 hours	VAR086/NB
32	master's degree	VAR088/NB
10	master's + 15 hours	VAR090/NB
6	master's + 30 hours	VAR092/NB
0/NC	EdD or PhD	0/NC

When was the last time you took a course for college credit?
(8 - no response)

_43_ this year (83-84)
_17_ last year (82-83)
_34_ 2 years ago (81-82)
_23_ 3 years ago (80-81)
_74_ 4 or more years ago

When was the last time you took an in-service course or workshop (no college credit) in an industrial arts topic?
(19 - no response)

_80_ this year (83-84)
_49_ last year (82-83)
_21_ 2 years ago (81-82)
_9_ 3 years ago (80-81)
_22_ 4 or more years ago

Have you taken a college-level course that included renewable energy topics?
(15 - no response)
no _147_ 1 or 2 _32_ 3 or 4 _3_ more than 4 _3_

Have you taken in-service course(s)/workshop(s) that dealt with renewable energy topics?
(12 - no response)
no _101_ 1 or 2 _67_ 3 or 4 _10_ more than 4 _10_

What has been your involvement in professional organizations (check those categories that currently apply or have applied in the last five years)?

	membership	office	committee work	formal presentations	regularly attend meetings, conventions, etc.
AIAA	43	2	1	1	5
AVA	20	1	1	1	3
NEIAA	37	4	7	1	9
NHIEA	59	5	10	5	15
NHVEA	16	1	1	1	7
NHSEA	5	O/NC	O/NC	O/NC	O/NC
NESEA	2	O/NC	O/NC	O/NC	O/NC
other (26)	24	9	10	4	14

Would you attend in-service workshops in renewable energy education topics next year?
(28 - no response) yes _155_ no _17_

List the names of five of your industrial arts colleagues from whom you would prefer to receive in-service training in renewable energy education. Assume that those five teachers would have received technical updating from energy experts.

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________

[See Nominations in Appendix H]

Would you like to receive a summary of the results of this study in renewable energy education?
(25 - no response) yes _148_ no _26_

Teacher Demographic Data: Totals for Coded Variables

What subjects have you taught this year?

VAR 148 Other Subjects/ Prime area of responsibility - Jr. High

Code	Description	Frequency
0	No response	184
1	Driver's education	3
4	Building Construction/Carpentry	4
5	World of Construction/Manufacturing	4
6	Art	1
7	Home repair	1
11	Leather	1
12	Plumbing	1
15	Outdoor education	1
		16

VAR 150 Other Subjects/Prime area of responsibility - Sr. High

Code	Description	Frequency
0	No response	186
1	Driver's education	3
4	Building construction/carpentry	3
8	Math	1
9	Vocational trade area	1
11	Leather	1
13	Special needs	2
14	Computer science/programming	1
98	Multiple listing (including Math/Science)	1
99	Multiple listing (no Math/Science)	1
		14

What subjects have you taught this year?

VAR 147 Administrative role/Prime area of responsibility - Jr. High

Code	Description	Frequency
0	No response	191
1	IA Department Chairperson	5
2	Assistant/Acting principal	1
3	Special needs	1
4	Curriculum Advisor	1
10	Computer Science	1
		9

VAR 149 Administrative role/Prime area of respnosibility - Sr. High

Code	Description	Frequency
0	No response	190
1	IA Department Chairperson	8
2	Assistant/Acting principal	1
5	Computer Studies Coordinator	1
		10

VAR 070 How many years have you been teaching (count this year). Total number of years.

Code (years)	Frequency	Code (years)	Frequency
0	4	18	9
1	6	19	5
2	11	20	7
3	5	21	4
4	5	22	5
5	6	23	3
6	5	24	6
7	9	25	4
8	9	26	4
9	9	27	1
10	8	28	3
11	11	29	2
12	7	30	3
13	7	31	2
14	9	32	1
15	16	37	1
16	7		
17	6		

VAR 072 How many years have you been teaching (count this year). Total number of years teaching industrial arts.

Code (years)	Frequency	Code (years)	Frequency
0	31	17	6
1	6	18	8
2	9	19	3
3	7	20	4
4	4	21	2
5	7	22	5
6	7	23	1
7	6	24	4
8	11	25	4
9	7	26	2
10	9	27	1
11	8	28	3
12	8	29	1
13	8	30	3
14	6	32	1
15	10	37	1
16	7		

VAR 073 How many years have you been teaching (count this year).
Number of years in your present school.

Code (years)	Frequency	Code (years)	Frequency
0	30	16	2
1	14	17	4
2	8	18	11
3	14	19	3
4	11	20	2
5	14	21	2
6	12	22	3
7	6	23	2
8	6	24	1
9	9	25	3
10	6	29	2
11	10	31	1
12	9	32	2
13	4	35	1
14	4		
15	4		

VAR 077 Teaching certificate(s) other than industrial arts.

Code	Description	Frequency
0	No response	165
1	Driver's Education	6
2	Vocational (trade area(s))	13
3	Social Science	1
5	Business Administration	1
7	Elementary Education	1
8	English	1
9	Physical Education	1
10	Elementary/Special Education	1
97	Not listed	3
98	Multiple listing (no Math/Science)	3
99	Multiple Listing (including Math/Science)	4

VAR 079 College-level coursework, but no degree.
Indicate the College's name.

Code	Description	Frequency
0	No response	171
1	Keene State College	3
3	Fitchburg State College	1
9	SUNY at Oswego	3
10	Black Hills State College	1
14	University of New Hampshire	2
17	New York City College	1
20	Eastern Kentucky University	1
31	Nashua Vo-Tech	1
35	County College of Morris	1
39	Institute Moderno Nacional	1
45	Rochester Institute of Technology	1
49	East Coast Aero Tech	1
51	University of New Mexico	1
98	College name not listed	5
99	Multiple listing	6

VAR 081 Bachelor's degree in industrial arts.
Indicate the College's name.

Code	Description	Frequency
0	No response	71
1	Keene State College	70
3	Fitchburg State College	7
4	University of Maryland	1
6	Western Michigan University	1
8	Trenton State College	2
9	SUNY at Oswego	5
15	University of Nebraska	1
16	Rhode Island College	3
26	University of Southern Maine	4
27	Central Michigan University	1
28	Oklahoma State University at Goodwell	1
30	University of Maine	1
34	Kean College of New Jersey	1
36	Central Connecticut State University	2
40	Millersville State University	1
44	University of Minnesota at Duluth	1
98	College name not listed	27

VAR 083 Bachelor's degree in a major other than industrial arts. Indicate the College's name.

Code	Description	Frequency
0	No response	163
1	Keene State College	2
2	Plymouth State College	3
4	University of Maryland	1
7	Salem State	1
9	SUNY at Oswego	1
14	University of New Hampshire	4
19	Boston Uniersity	1
21	University of Louisville	1
24	Pratt Institute	1
29	Saint Anselm College	2
40	Millersville State University	1
43	Bridgewater State	1
98	College name not listed	18

VAR 084 Bachelor's degree in a major other than industrial arts. Name of major.

Code	Description	Frequency
0	No response	169
2	Mathematics	1
3	Human Services	1
4	Psychology	3
5	Fine Arts	1
6	Social Science	3
7	Vocational Education	4
8	Management	2
9	Physical Education	3
10	Home Economics	1
11	Biology	1
12	Engineering	1
14	Elementary Education	1
15	English/Language Arts	2
16	General Studies	1
17	Chemistry	1
98	Multiple listing (no Math/Science)	3
99	Multiple listing (including Math/Science)	2

VAR 086 Bachelor's + 15 hours. Indicate the College's name.

Code	Description	Frequency
0	No response	157
1	Keene State College	4
2	Plymouth State College	2
3	Fitchburg State College	1
9	SUNY at Oswego	4
11	Notre Dame College	1
14	University of New Hampshire	4
19	Boston University	1
22	Lowell Tech	1
26	University of Southern Maine	1
27	Central Michigan University	1
33	Navy	1
98	College name not listed	18
99	Multiple listing	4

VAR 088 Master's degree. Indicate the College's name.

Code	Description	Frequency
0	No response	165
1	Keene State College	2
2	Plymouth State College	3
3	Fitchburg State College	2
4	University of Maryland	1
5	Albany State College	1
7	Salem State	1
11	Notre Dame College	1
12	Indiana State University	1
14	University of New Hampshire	5
18	Seton Hall	1
19	Boston University	1
23	Dartmouth College	1
25	California Institute of Fine Arts	1
26	University of Southern Maine	1
30	University of Maine	2
32	University of Connecticut	2
41	Antioch	1
98	College not listed	7
99	Multiple listing	1

VAR 090 Master's + 15 hours. Indicate the College's name.

Code	Description	Frequency
0	No response	189
1	Keene State College	3
4	University of Maryland	1
14	University of New Hampshire	1
32	University of Connecticut	1
41	Antioch	1
98	College name not listed	4

VAR 092 Master's + 30 hours. Indicate the College's name.

Code	Description	Frequency
0	No response	195
14	University of New Hampshire	1
98	College name not listed	3
1	Multiple listing	1